TEST REPORT

Test Report No.: 1-2205-01-11/10-B

Testing Laboratory

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Accredited Test Laboratory:
The test laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025

DAR registration number: DGA-PL-176/94-D1

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Manufacturer

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Test Standard/s

ICNIRP Guidelines	Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)
FCC OET Bulletin 65	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
AS/NZS 2772.1	Radiofrequency fields, Part 1: Maximum exposure limits - 3 kHz to 300 GHz

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	PCIe Wireless mini card
Device type:	mobile device used in different generic scenarios
Model name:	**F5521gw**
S/N serial number:	A401168081
FCC-ID:	VV7-MBMF5521GW1
IC:	287AG-MBMF5521GW1
IMEI-Number:	n.a.
HW hardware status:	R1
SW software status:	R1A29
Frequency:	see technical details
Exposure category:	general population / uncontrolled environment

This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test Report authorised:

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2010-10-12 Bernd Rebmann

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2010-10-12 Thomas Vogler

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2 General information

2.1 Notes

The test results of this test report relate exclusively to the test item specified in this test report. CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM ICT Services GmbH.
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2.2 Application details

Date of receipt of order:	2010-07-02
Date of receipt of test item:	2010-08-16
Start of test:	2010-09-16
End of test:	2010-10-12
Person(s) present during the test:	

2.3 Statement of compliance

The EMF values found for the F5521gw PCIe Wireless mini card are below the maximum allowed levels according to the standards listed in section 3, when used with an antenna with maximum gain as listed in chapter 4.4.

2.4 Technical details

Band tested for this MPE-calculation	Technology	Frequency band	Lowest transmit frequency/MHz	Highest transmit frequency/MHz	Lowest receive Frequency/MHz	Highest receive Frequency/MHz	Kind of modulation	Power Class	Tested power control level	GPRS/EGPRS mobile station class	GPRS/EGPRS multislot class	(E)GPRS voice mode or DTM	Test channel low	Test channel middle	Test channel high	measured maximum output power/dBm)*
☒	GSM	GSM	880.2	914.8	925.2	959.8	GMSK 8-PSK	4 E2	5	B	10	no	975	37	124	32.40
☒	GSM	DCS	1710.2	1784.8	1805.2	1879.8	GMSK 8-PSK	1 E2	0	B	10	no	512	698	885	29.60
☒	GSM	cellular	824.2	848.8	869.2	893.8	GMSK 8-PSK	4 E2	5	B	10	no	128	190	251	32.49
☒	GSM	PCS	1850.2	1909.8	1930.2	1989.8	GMSK 8-PSK	1 E2	0	B	10	no	512	661	810	29.61
☒	UMTS	FDD I	1922.4	1977.6	2112.4	2167.6	QPSK	3	max	--	--	--	9612	9750	9888	23.90
☒	UMTS	FDD II	1852.4	1907.6	1982.4	1987.6	QPSK	3	max	--	--	--	9262	9400	9538	22.80
☒	UMTS	FDD VI	832.4	837.6	877.4	882.6	QPSK	3	max	--	--	--	4162	4175	4188	23.95
☒	UMTS	FDD V	826.4	846.6	871.4	891.6	QPSK	3	max	--	--	--	4132	4182	4233	23.95
☒	UMTS	FDD VIII	882.4	912.6	927.4	957.6	QPSK	3	max	--	--	--	2712	2787	2863	23.80

)*: slotted peak power for GSM, averaged max. RMS power for UMTS, WLAN and BT.

3 Test standard/s:

Test Standard	Version	Test Standard Description
ICNIRP Guidelines	1998-04	Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)
EN62311	2008-05	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz
1999/519/EC	1999-07	Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 197 of 30 July 1999)
FCC OET Bulletin 65	1997-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
FCC 47 CFR §1.1307	2005-10	Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.
FCC 47 CFR §1.1310	2005-10	Radiofrequency radiation exposure limits
RSS-102 Issue 4	2010-03	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
AS/NZS 2772.1	1998-01	Radiofrequency fields, Part 1: Maximum exposure limits - 3 kHz to 300 GHz
AS 2772.2	1998-01	Radiofrequency radiation, Part 2: Principles and methods of measurement—300 kHz to 100 GHz
ARPANSA RPS No. 3	2002-03	Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz
Vodafone req. 1999/519/EC		

3.1 Purpose of this report

The purpose of this report is to show the compliance of certain simultaneous transmission configurations for use in mobile exposure conditions.

In addition to basic requirements of the standards listed above (including FCC Part 22 H and Part 24 E) the following requirements have been taken into account:

- The module must be categorically excluded by FCC 47 CFR § 2.1091 (c) and the antenna separation distance and MPE compliance boundary requirements that enable all simultaneous transmitting antennas incorporated within the host shall comply with MPE limits as specified in FCC 47 CFR § 1.1310.
  (see chapter 8 of FCC KDB 447498 D01 Mobile Portable RF Exposure)

If these requirements are kept the module can be incorporated in mobile host devices without further testing or certification.

4 Evaluating compliance with requirements for human exposure to EMFs

4.1 Maximum permissible exposure (MPE)

Fixed/mobile exposure conditions of multiple transmitters installed in different hosts represent the most difficult situation in terms of the determination of minimum safety distances.
While EMF measurements most often only refer to a single configuration with only one transmitter or with multiple co-located transmitters a general approach is needed to determine a worst case condition under which several transmitters and their antennas can be installed to prevent additional RF exposure evaluation for each host.
This test report illustrates different scenarios how radio modules can be integrated in notebook hosts without the need of further testing.
The target is to determine a maximum EIRP or antenna gain for a WWAN module using GSM and/or UMTS frequencies, which is used stand-alone or collocated with other antennas for WLAN, Bluetooth, WiMAX etc.

The background of the calculation is a minimum distance of 20 cm between antenna(s) and user (mobile exposure condition), and the compliance with the requirements of chapter 3.1.

4.2 Limits and normative references

There is a number of international and national regulations, standards and guidelines for exposure to electromagnetic fields. For the evaluations in this report the following reference levels have been applied.

4.2.1 FCC and IC requirements

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field strength (µT)	Power density (mW/cm²)
300 – 1500 MHz	--	--	--	f(MHz) / 1500
1.5 – 100 GHz	--	--	--	1.0

Categorically exclusion per § 2.1091 (c) : - below 1.5 GHz : avg. ERP < 1.5 W (= 33.9 dBm EIRP)
- above 1.5 GHz : avg. ERP < 3 W (= 36.9 dBm EIRP)

Part 22 H ERP limit : max. 7 W (38.45 dBm) burst power (= 40.6 dBm EIRP)
Part 24 E EIRP limit : max. 2 W (33.0 dBm) burst power

4.2.2 EN requirements

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field strength (µT)	Power density (mW/cm²)
400 – 2000 MHz	$1.375*f(MHz)^{1/2}$	$0.0037*f(MHz)^{1/2}$	$0.0046*f(MHz)^{1/2}$	f(MHz) / 2000
2 – 300 GHz	61	0.16	0.2	1.0

4.2.3 Australian requirements

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field strength (µT)	Power density (mW/cm²)
400 – 2000 MHz	$1.375*f(MHz)^{1/2}$	$0.0037*f(MHz)^{1/2}$	$0.0046*f(MHz)^{1/2}$	f(MHz) / 2000
2 – 300 GHz	61	0.16	0.2	1.0

Reference levels are provided for exposure assessment to determine whether the basic restrictions on exposure of humans to electromagnetic fields are exceeded. The basic restrictions on exposure to electromagnetic fields are based directly on established health effects and biological considerations.

4.3 Conducted power analysis

For the measurements a Rohde & Schwarz Radio Communication Tester CMU 200 was used.
The output power was measured using an integrated RF connector and attached RF cable.

Note: CMU200 measures GSM peak and average output power for active timeslots.
For MPE calculations the timebased average power is relevant. The difference inbetween depends on the duty cycle of the TDMA signal :

No. of timeslots	***1***	***2***	***3***	***4***
Duty Cycle	1 : 8	1: 4	1 : 2.66	1 : 2
timebased avg. power compared to slotted avg. power	- 9 dB	- 6 dB	- 4.25 dB	- 3 dB

The signalling modes differ as follows :

mode	***coding scheme***	***modulation***
GPRS	CS1 to CS4	GMSK
EGPRS (EDGE)	MCS1 to MCS4	GMSK
EGPRS (EDGE)	MCS5 to MCS9	8PSK

Apart from modulation change (GMSK/8PSK) coding schemes differ in code rate without influence on the RF signal. Therefore one coding scheme per mode was selected for conducted power measurements. The frequency with the highest output power per band was used for this analysis.

band	modulation	timeslots	slotted avg. power (measured)	max. power from tune up info	time based avg. power (calculated)
GSM 850	GMSK	1	32.50dBm	33.50dBm	**24.50dBm**
GSM 850	GMSK	2	30.20dBm	30.50dBm	24.50dBm
GSM 850	GMSK	3	28.40dBm	28.50dBm	24.25dBm
GSM 850	GMSK	4	27.20dBm	27.50dBm	24.50dBm
GSM 850	8PSK	1	26.60dBm	27.50dBm	**18.50dBm**
GSM 850	8PSK	2	24.40dBm	24.50dBm	18.50dBm
GSM 850	8PSK	3	22.40dBm	22.50dBm	18.25dBm
GSM 850	8PSK	4	21.40dBm	21.50dBm	18.50dBm

Table 1: Test results conducted power measurement GSM 850 MHz

band	modulation	timeslots	slotted avg. power (measured)	max. power from tune up info	time based avg. power (calculated)
GSM 900	GMSK	1	32.40dBm	33.50dBm	**24.50dBm**
GSM 900	GMSK	2	30.20dBm	30.50dBm	24.50dBm
GSM 900	GMSK	3	28.40dBm	28.50dBm	24.25dBm
GSM 900	GMSK	4	27.20dBm	27.50dBm	24.50dBm
GSM 900	8PSK	1	27.30dBm	27.50dBm	**18.50dBm**
GSM 900	8PSK	2	24.30dBm	24.50dBm	18.50dBm
GSM 900	8PSK	3	22.30dBm	22.50dBm	18.25dBm
GSM 900	8PSK	4	21.30dBm	21.50dBm	18.50dBm

Table 2: Test results conducted power measurement GSM 900 MHz

band	modulation	timeslots	slotted avg. power (measured)	max. power from tune up info	time based avg. power (calculated)
GSM 1800	GMSK	1	29.60dBm	30.50dBm	**21.50dBm**
GSM 1800	GMSK	2	27.40dBm	27.50dBm	21.50dBm
GSM 1800	GMSK	3	25.40dBm	25.50dBm	21.25dBm
GSM 1800	GMSK	4	24.40dBm	24.50dBm	21.50dBm
GSM 1800	8PSK	1	26.40dBm	26.50dBm	**17.50dBm**
GSM 1800	8PSK	2	23.40dBm	23.50dBm	17.50dBm
GSM 1800	8PSK	3	21.40dBm	21.50dBm	17.25dBm
GSM 1800	8PSK	4	20.40dBm	20.50dBm	17.50dBm

Table 3: Test results conducted power measurement GSM 1800 MHz

band	modulation	timeslots	slotted avg. power (measured)	max. power from tune up info	time based avg. power (calculated)
GSM 1900	GMSK	1	29.60dBm	30.50dBm	**21.50dBm**
GSM 1900	GMSK	2	27.30dBm	27.50dBm	21.50dBm
GSM 1900	GMSK	3	25.50dBm	25.50dBm	21.25dBm
GSM 1900	GMSK	4	24.30dBm	24.50dBm	21.50dBm
GSM 1900	8PSK	1	25.90dBm	26.50dBm	**17.50dBm**
GSM 1900	8PSK	2	24.70dBm	23.50dBm	17.50dBm
GSM 1900	8PSK	3	22.50dBm	21.50dBm	17.25dBm
GSM 1900	8PSK	4	21.70dBm	20.50dBm	17.50dBm

Table 4: Test results conducted power measurement GSM 1900 MHz

band	modulation	timeslots	avg. power (measured)	max. power from tune up info	time based avg. power (calculated)
FDD I	QPSK	---	23.90dBm	24.00dBm	**24.00dBm**
FDD II	QPSK	---	22.80dBm	23.00dBm	**23.00dBm**
FDD V	QPSK	---	23.95dBm	24.00dBm	**24.00dBm**
FDD VIII	QPSK	---	23.80dBm	24.00dBm	**24.00dBm**

Table 5: Test results conducted power measurement UMTS (WCDMA) frequency bands

4.4 Host platform analysis

The MPE calculation has been performed for different scenarios of stand-alone and co-located operation of the WWAN module described below and generic radio modules with different communication systems.

WWAN module :	PCIe Wireless mini card	Notes :
type :	KRD 131 18/1	
model :	F5521gw	
FCC-ID :	VV7-MBMF5521GW1	
IC-ID :	287AG- MBMF5521GW1	
Maximum antenna gain < 1 GHz	**6.55 dBi**	limitation by ICNIRP RF exposure limit **(collocation with WLAN and/or WiMAX)**
Maximum antenna gain < 1 GHz	**7.10 dBi**	limitation by FCC Part 22 H EIRP limit)* **(standalone or collocation with BT only)**
Maximum antenna gain > 1.7 GHz	**2.50 dBi**	limitation by FCC Part 24 E EIRP limit)*

)* FCC limits for maximum E(I)RP are overlaying maximum exposure limits.

The table below lists the calculated maximum EIRP values which represent the worst case condition of all standards and limits listed in chapter 4.2.
Unless peak burst power is required for evaluation the GSM timeslot configuration with highest time based average power has been used for calculation.

a) Maximum antenna gain determination in stand-alone situation. For details see annex A.1.

Communication system	Mode	Frequency (MHz)	Conducted power (dBm) *	Antenna gain (dBi)	Duty Cycle (%)	PAR (dB)	EIRP (dBm)**	EIRP (mW)**
GSM 850	GSM/GPRS	824.2 - 848.8	33.50	7.10	12.5	9	31.60	1445.44
	EDGE	824.2 - 848.8	27.50	7.10	12.5	9	25.60	363.08
FDD V/VI	WCDMA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
	HSDPA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
	HSUPA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
E-GSM 900	GSM/GPRS	880.2 - 914.8	33.50	7.10	12.5	9	31.60	1445.44
	EDGE	880.2 - 914.8	27.50	7.10	12.5	9	25.60	363.08
FDD VIII	WCDMA	882.4 - 912.6	24.00	7.10	100	0	31.10	1288.25
	HSDPA	882.4 - 912.6	24.00	7.10	100	0	31.10	1288.25
	HSUPA	882.4 - 912.6	24.00	7.10	100	0	31.10	1288.25
DCS 1800	GSM/GPRS	1710.2 - 1784.8	30.50	2.50	12.5	9	24.00	251.19
	EDGE	1710.2 - 1784.8	26.50	2.50	12.5	9	20.00	100.00
PCS 1900	GSM/GPRS	1850.2 - 1909.8	30.50	2.50	12.5	9	24.00	251.19
	EDGE	1850.2 - 1909.8	26.50	2.50	12.5	9	20.00	100.00
FDD II	WCDMA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81
	HSDPA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81
	HSUPA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81
FDD I	WCDMA	1922.4 - 1977.6	24.00	2.50	100	0	26.50	446.68
	HSDPA	1922.4 - 1977.6	24.00	2.50	100	0	26.50	446.68
	HSUPA	1922.4 - 1977.6	24.00	2.50	100	0	26.50	446.68

b) Maximum antenna gain determination in collocated scenarios. For details see annex A.1 and A.2.

Communication system	Mode	Frequency (MHz)	Conducted power (dBm) *	Antenna gain (dBi)	Duty Cycle (%)	PAR (dB)	EIRP (dBm)**	EIRP (mW)**
GSM 850	GSM/GPRS	824.2 - 848.8	33.50	7.10	12.5	9	31.60	1445.44
	EDGE	824.2 - 848.8	27.50	7.10	12.5	9	25.60	363.08
FDD V/VI	WCDMA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
	HSDPA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
	HSUPA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
FDD V (Australia)	WCDMA	826.4 - 846.6	24.00	**6.77**	100	0	30.77	1193.99
	HSDPA	826.4 - 846.6	24.00	**6.77**	100	0	30.77	1193.99
	HSUPA	826.4 - 846.6	24.00	**6.77**	100	0	30.77	1193.99
E-GSM 900	GSM/GPRS	880.2 - 914.8	33.50	**6.55**	12.5	9	31.05	1273.50
	EDGE	880.2 - 914.8	27.50	**6.55**	12.5	9	25.05	319.89
FDD VIII	WCDMA	882.4 - 912.6	24.00	**6.55**	100	0	30.55	1135.01
	HSDPA	882.4 - 912.6	24.00	**6.55**	100	0	30.55	1135.01
	HSUPA	882.4 - 912.6	24.00	**6.55**	100	0	30.55	1135.01
DCS 1800	GSM/GPRS	1710.2 - 1784.8	30.50	2.50	12.5	9	24.00	251.19
	EDGE	1710.2 - 1784.8	26.50	2.50	12.5	9	20.00	100.00
PCS 1900	GSM/GPRS	1850.2 - 1909.8	30.50	2.50	12.5	9	24.00	251.19
	EDGE	1850.2 - 1909.8	26.50	2.50	12.5	9	20.00	100.00
FDD II	WCDMA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81
	HSDPA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81
	HSUPA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81
FDD I	WCDMA	1922.4 - 1977.6	24.00	2.50	100	0	26.50	446.68
	HSDPA	1922.4 - 1977.6	24.00	2.50	100	0	26.50	446.68
	HSUPA	1922.4 - 1977.6	24.00	2.50	100	0	26.50	446.68

For the generic communication systems the following worst case technical data have been assumed.

Communication system	Mode	Frequency (MHz)	Conducted power (dBm) *	Antenna gain (dBi)	Duty Cycle (%)	PAR (dB)	EIRP (dBm)**	EIRP (mW)**
Bluetooth		2.4 GHz Range	20	0.00	76	1.2	18.80	131.83
WLAN		2.4 / 5 GHz Range	33 ***	0.00	100	0	33.00	1995.26
WiMAX		various	33 ***	0.00	100	0	33.00	1995.26

*: slotted peak power of 1 time slot for GSM, maximum RMS for all other communication systems
**: time based averaged
***: or sum of WLAN + WiMAX = 33 dBm (2 W)

c) Maximum antenna gain with ERP Limitation by FCC 47 CFR § 2.1091 (c)

Communication system	Mode	Frequency (MHz)	Conducted power (dBm) *	Antenna gain (dBi)	Duty Cycle (%)	PAR (dB)	EIRP (dBm)**	EIRP (mW)**
GSM 850	GSM/GPRS	824.2 - 848.8	33.50	7.10	12.5	9	31.60	1445.44
FDD V	WCDMA	826.4 - 846.6	24.00	7.10	100	0	31.10	1288.25
PCS 1900	GSM/GPRS	1850.2 - 1909.8	30.50	2.50	12.5	9	24.00	251.19
FDD II	WCDMA	1852.4 - 1907.6	23.00	2.50	100	0	25.50	354.81

d) Maximum antenna gain with E(I)RP Limitation by FCC Part 22 H and Part 24 E

Communication system	Mode	Frequency (MHz)	Conducted power (dBm) *	Antenna gain (dBi)	Duty Cycle (%)	PAR (dB)	EIRP (dBm)**	EIRP (mW)**
GSM 850	GSM/GPRS	824.2 - 848.8	**33.50**	**7.10**	12.5	9	31.60	1445.44
FDD V	WCDMA	826.4 - 846.6	24.00	**7.10**	100	0	31.10	1288.25
PCS 1900	GSM/GPRS	1850.2 - 1909.8	**30.50**	**2.50**	12.5	9	24.00	251.19
FDD II	WCDMA	1852.4 - 1907.6	23.00	**2.50**	100	0	25.50	354.81

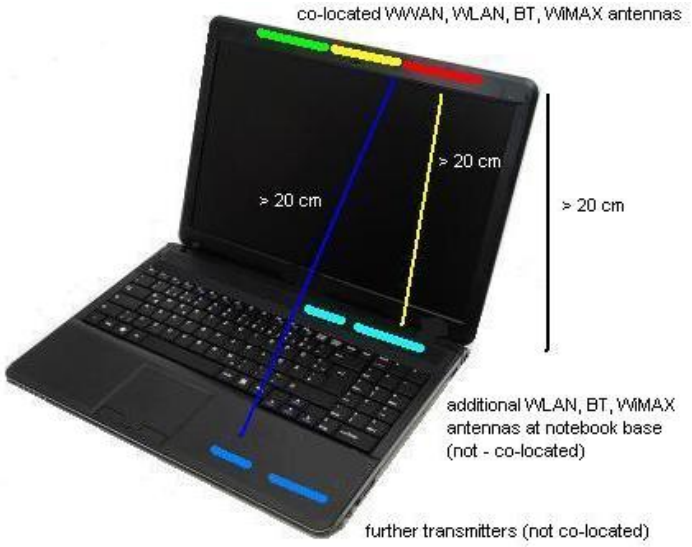
*: slotted peak power for GSM, maximum RMS for all other communication systems
**: time based averaged

Additional illustration:

- Table a) shows the maximum antenna gain for the WWAN module so that the worst case power density limits are met in stand-alone configuration.
- Table b) shows the maximum antenna gain for the WWAN module so that the worst case power density limits are met in all collocated scenarios.
- Table c) shows the maximum antenna gain of the WWAN module so that FCC ERP limits for time based averaged power are met.
- Table d) shows the maximum antenna gain of the WWAN module so that FCC E(I)RP limits for burst power are met.

The lowest calculated antenna gain values (shown in bold letters) determine the highest allowed antenna gain of the WWAN module in stand-alone and collocated scenarios.

Antenna configuration for all scenarios:



Important note: this notebook configuration is an example. Different applications (e.g. M2M) are also possible as long as the same antenna-to-antenna and antenna-to-user distances are respected.

4.4.1 Scenario 0 : WWAN stand-alone

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**
communication system	**WWAN (GSM/UMTS)**
type	**KRD 131 18/1**
model	**F5521gw**
FCC-ID	VV7-MBMF5521GW1
IC-ID	287AG- MBMF5521GW1
max. EIRP (mW)	**see chapter 4.4**
max.antenna gain	**7.10 dBi / 2.50 dBi**

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

4.4.2 Scenario 1 : WWAN + BT

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary
communication system	**WWAN (GSM/UMTS)**	BT
type	**KRD 131 18/1**	any
model	**F5521gw**	any
FCC-ID	VV7-MBMF5521GW1	any
IC-ID	287AG- MBMF5521GW1	any
max. EIRP (mW)	**see chapter 4.4**	76.43
max.antenna gain	**7.10 dBi / 2.50 dBi**	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the BT module does not exceed the value listed above
- the distance between WWAN and BT antennas is 0 cm or larger

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

4.4.3 Scenario 2 : WWAN + WLAN

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary
communication system	**WWAN (GSM/UMTS)**	WLAN
type	**KRD 131 18/1**	any
model	**F5521gw**	any
FCC-ID	VV7-MBMF5521GW1	any
IC-ID	287AG- MBMF5521GW1	any
max. EIRP (mW)	**see chapter 4.4**	1995.26
max.antenna gain	**6.55 dBi / 2.50 dBi**	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the WLAN module does not exceed the value listed above
- the distance between WWAN and WLAN antennas is 0 cm or larger

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm).

4.4.4 Scenario 3 : WWAN + WLAN + BT

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary	
communication system	**WWAN (GSM/UMTS)**	BT	WLAN
type	**KRD 131 18/1**	any	any
model	**F5521gw**	any	any
FCC-ID	VV7-MBMF5521GW1	any	any
IC-ID	287AG- MBMF5521GW1	any	any
max. EIRP (mW)	**see chapter 4.4**	76.43	1995.26
max.antenna gain	**6.55 dBi / 2.50 dBi**	nn	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the WLAN module does not exceed the value listed above
- the averaged EIRP of the BT module does not exceed the value listed above
- the distance between WWAN, WLAN and BT antennas is 0 cm or larger

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

4.4.5 Scenario 4 : WWAN + WiMAX

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary
communication system	**WWAN (GSM/UMTS)**	WiMAX
type	**KRD 131 18/1**	any
model	**F5521gw**	any
FCC-ID	VV7-MBMF5521GW1	any
IC-ID	287AG- MBMF5521GW1	any
max. EIRP (mW)	**see chapter 4.4**	1995.26
max.antenna gain	**6.55 dBi / 2.50 dBi**	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the WiMAX module does not exceed the value listed above
- the distance between WWAN and WiMAX antennas is 0 cm or larger

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

4.4.6 Scenario 5 : WWAN + WiMAX + BT

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary	
communication system	**WWAN (GSM/UMTS)**	BT	WiMAX
type	**KRD 131 18/1**	any	any
model	**F5521gw**	any	any
FCC-ID	VV7-MBMF5521GW1	any	any
IC-ID	287AG- MBMF5521GW1	any	any
max. EIRP (mW)	**see chapter 4.4**	76.43	1995.26
max.antenna gain	**6.55 dBi / 2.50 dBi**	nn	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the WiMAX module does not exceed the value listed above
- the averaged EIRP of the BT module does not exceed the value listed above
- the distance between WWAN, WiMAX and BT antennas is 0 cm or larger

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

4.4.7 Scenario 6 : WWAN + WiMAX + WLAN

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary	
communication system	**WWAN (GSM/UMTS)**	WLAN	WiMAX
type	**KRD 131 18/1**	any	any
model	**F5521gw**	any	any
FCC-ID	VV7-MBMF5521GW1	any	any
IC-ID	287AG- MBMF5521GW1	any	any
max. EIRP (mW)	**see chapter 4.4**	sum: 1995.26	
max.antenna gain	**6.55 dBi / 2.50 dBi**	nn	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the WiMAX module does not exceed the value listed above
- the averaged EIRP of the WLAN module does not exceed the value listed above
- the distance between WWAN, WiMAX and WLAN antennas is 0 cm or larger

Note: other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

4.4.8 Scenario 7 : WWAN + WiMAX + WLAN + BT

This scenario covers the following combination of collocated radio modules:

Transmitter	**primary**	secondary		
communication system	**WWAN (GSM/UMTS)**	BT	WLAN	WiMAX
type	**KRD 131 18/1**	any	any	any
model	**F5521gw**	any	any	any
FCC-ID	VV7-MBMF5521GW1	any	any	any
IC-ID	287AG- MBMF5521GW1	any	any	any
max. EIRP (mW)	**see chapter 4.4**	76.43	sum: 1995.26	
max.antenna gain	**6.55 dBi / 2.50 dBi**	nn	nn	nn

This scenario covers the following conditions:

- the antenna-to-user distance of all transmitters listed above is 20 cm or larger
- the maximum antenna gain of the WWAN transmitters does not exceed the values listed above
- the averaged EIRP of the WiMAX module does not exceed the value listed above
- the averaged EIRP of the WLAN module does not exceed the value listed above
- the averaged EIRP of the BT module does not exceed the value listed above
- the distance between WWAN, WiMAX, WLAN and BT antennas is 0 cm or larger

Note : other antennas for different communication systems may be installed in the host platform as long as they are not collocated to the WWAN antenna (distance > 20 cm)

Annex A: RF Exposure assessment

Annex A.1: Individual transmitters

The table on the following page lists all calculated power density values in relation to the limits defined in different standards, calculated for a distance of 20 cm from the antenna(s).

Fundamental data for calculating worst case EIRP of the primary and secondary transmitters are listed in chapter 4.3.

Equivalent power density at a distance of 20 cm is calculated by using the following formula:

$S_{eq} = P \cdot G / 4\pi \cdot r^2$ with P*G = EIRP and r = 20 cm

Then the ratio $S_{eq} / S_{\lim}$ is calculated for all applied limits.

During calculation the maximum EIRP of the primary transmitter is optimized so that the ratio S_{eq} / S_{lim} does not exceed a value of 1 for all applied limits for a comprehensive coverage of all relevant standards.

The calculation of S_{eq} / S_{lim} with reference to a certain standard is limited to those frequency bands that are generally used in regions where this standard is applied.

standard	EN	FCC/IC	AUS/NZ
region	Europe	USA,Canada	Australia New Zealand
GSM 850		x	
UMTS FDD V		x	x
(E)GSM 900	x		x
UMTS FDD VIII	x		
DCS 1800	x		x
UMTS FDD IV		x	
PCS 1900		x	
UMTS FDD II		x	
UMTS FDD I	x		x
ISM (WLAN/BT)	x	x	x
WiMAX	x	x	x

Note:
For frequencies above 2 GHz the limit is constant for all standards.
Therefore no frequency dependent differentiation is needed for radio technologies in this frequency band.

Stand-alone power density overview and limit reference of WWAN communication systems :

Comm. System	Mode	Reference Frequency	EIRP (mW)	Distance (cm)	Power Density Seq (mW/cm²)	MPE Limit (mW/cm²) EN	S_{eq} / S_{Lim} EN	MPE Limit (mW/cm²) FCC/IC	S_{eq} / S_{Lim} FCC	MPE Limit (mW/cm²) AUS	S_{eq} / S_{Lim} AUS
GSM 850	GSM/GPRS	824.2	1445.44	20	0.2876	0.4121		0.5495	0.5233	0.4121	
	EDGE	824.2	363.08	20	0.0722	0.4121		0.5495	0.1315	0.4121	
FDD V/VI	WCDMA	826.4	1288.25	20	0.2563	0.4132		0.5509	0.4652	0.4132	0.6203
	HSDPA	826.4	1288.25	20	0.2563	0.4132		0.5509	0.4652	0.4132	0.6203
	HSUPA	826.4	1288.25	20	0.2563	0.4132		0.5509	0.4652	0.4132	0.6203
E-GSM 900	GSM/GPRS	880.2	1445.44	20	0.2876	0.4401	0.6534	0.5868		0.4401	0.6534
	EDGE	880.2	363.08	20	0.0722	0.4401	0.1641	0.5868		0.4401	0.1641
FDD VIII	WCDMA	882.4	1288.25	20	0.2563	0.4412	0.5809	0.5883		0.4412	
	HSDPA	882.4	1288.25	20	0.2563	0.4412	0.5809	0.5883		0.4412	
	HSUPA	882.4	1288.25	20	0.2563	0.4412	0.5809	0.5883		0.4412	
DCS 1800	GSM/GPRS	1710.2	251.19	20	0.0500	0.8551	0.0584	1.0000		0.8551	0.0584
	EDGE	1710.2	100.00	20	0.0199	0.8551	0.0233	1.0000		0.8551	0.0233
PCS 1900	GSM/GPRS	1850.2	251.19	20	0.0500	0.9251		1.0000	0.0500	0.9251	
	EDGE	1850.2	100.00	20	0.0199	0.9251		1.0000	0.0199	0.9251	
FDD II	WCDMA	1852.4	354.81	20	0.0706	0.9262		1.0000	0.0706	0.9262	
	HSDPA	1852.4	354.81	20	0.0706	0.9262		1.0000	0.0706	0.9262	
	HSUPA	1852.4	354.81	20	0.0706	0.9262		1.0000	0.0706	0.9262	
FDD I	WCDMA	1922.4	446.68	20	0.0889	0.9612	0.0925	1.0000		0.9612	0.0925
	HSDPA	1922.4	446.68	20	0.0889	0.9612	0.0925	1.0000		0.9612	0.0925
	HSUPA	1922.4	446.68	20	0.0889	0.9612	0.0925	1.0000		0.9612	0.0925
worst case S_{eq} / S_{Lim}						**EN**	**0.6534**	**FCC**	**0.5233**	**AUS**	**0.6534**

Stand-alone power density overview and limit reference of WWAN communication systems and possible collocated transmitters :

Comm. System	Mode	Reference Frequency	EIRP (mW)	Distance (cm)	Power Density Seq (mW/cm²)	MPE Limit (mW/cm²) EN	S_{eq} / S_{Lim} EN	MPE Limit (mW/cm²) FCC	S_{eq} / S_{Lim} FCC	MPE Limit (mW/cm²) AUS	S_{eq} / S_{Lim} AUS	MPE Limit (mW/cm²) Vodafone	S_{eq} / S_{Lim} Vodafone
GSM 850	GSM/GPRS	824,2	1445,44	20	0,2876	0,4121		0,5495	0,5233	0,4121		0,4121	0,6978
	EDGE	824,2	363,08	20	0,0722	0,4121		0,5495	0,1315	0,4121		0,4121	0,1753
FDD V	WCDMA	826,4	1193,99	20	0,2375	0,4132		0,5509	0,4312	0,4132	0,5749	0,4132	0,5749
	HSDPA	826,4	1193,99	20	0,2375	0,4132		0,5509	0,4312	0,4132	0,5749	0,4132	0,5749
	HSUPA	826,4	1193,99	20	0,2375	0,4132		0,5509	0,4312	0,4132	0,5749	0,4132	0,5749
E-GSM 900	GSM/GPRS	880,2	1273,50	20	0,2534	0,4401	0,5757	0,5868		0,4401	0,5757	0,4401	0,5757
	EDGE	880,2	319,89	20	0,0636	0,4401	0,1446	0,5868		0,4401	0,1446	0,4401	0,1446
FDD VIII	WCDMA	882,4	1135,01	20	0,2258	0,4412	0,5118	0,5883		0,4412		0,4412	0,5118
	HSDPA	882,4	1135,01	20	0,2258	0,4412	0,5118	0,5883		0,4412		0,4412	0,5118
	HSUPA	882,4	1135,01	20	0,2258	0,4412	0,5118	0,5883		0,4412		0,4412	0,5118
DCS 1800	GSM/GPRS	1710,2	1548,82	20	0,3081	0,8551	0,3603	1,0000		0,8551	0,3603	0,8551	0,3603
	EDGE	1710,2	616,60	20	0,1227	0,8551	0,1435	1,0000		0,8551	0,1435	0,8551	0,1435
PCS 1900	GSM/GPRS	1850,2	1548,82	20	0,3081	0,9251		1,0000	0,3081	0,9251		0,9251	0,3331
	EDGE	1850,2	616,60	20	0,1227	0,9251		1,0000	0,1227	0,9251		0,9251	0,1326
FDD II	WCDMA	1852,4	2187,76	20	0,4352	0,9262		1,0000	0,4352	0,9262		0,9262	0,4699
	HSDPA	1852,4	2187,76	20	0,4352	0,9262		1,0000	0,4352	0,9262		0,9262	0,4699
	HSUPA	1852,4	2187,76	20	0,4352	0,9262		1,0000	0,4352	0,9262		0,9262	0,4699
FDD I	WCDMA	1922,4	2754,23	20	0,5479	0,9612	0,5701	1,0000		0,9612	0,5701	0,9612	0,5701
	HSDPA	1922,4	2754,23	20	0,5479	0,9612	0,5701	1,0000		0,9612	0,5701	0,9612	0,5701
	HSUPA	1922,4	2754,23	20	0,5479	0,9612	0,5701	1,0000		0,9612	0,5701	0,9612	0,5701
worst case S_{eq} / S_{Lim}						**EN**	**0,5757**	**FCC**	**0,5233**	**AUS**	**0,5757**	**VF**	**0,6978**
Collocated transmitters :													
Bluetooth		2450	131,83	20	0,0262	1	0,0262	1	0,0262	1	0,0262	1	0,0262
WLAN		2450	1995,26	20	0,3969	1	0,3969	1	0,3969	1	0,3969	1	0,3969
WiMax		2300	1995,26	20	0,3969	1	0,3969	1	0,3969	1	0,3969	1	0,3969

Annex A.2: Collocated transmitters

When transmitters with collocated antennas are active simultaneously a worst case assessment is necessary which takes additive effects into account.

In this case it must be insured that the sum of all worst case power densities of all active transmitters (according to the different scenarios) do not exceed the limits even if they are far below the limits for the single transmitter.

$$\sum_{1}^{n} \frac{S_{eqn}}{S_{\lim n}} = \frac{S_{eq1}}{S_{\lim 1}} + \frac{S_{eq2}}{S_{\lim 2}} + \ldots + \frac{S_{eqn}}{S_{\lim n}} \leq 1$$

The following tables show the results separated for different limits according to the standards listed in chapter 4.2.
The sum that comes closest to 1 represents the worst case and limits the antenna gain that is allowed for the WWAN module.

a) Simultaneous Exposure according to FCC and IC limits

Scenario	Combination		worst case Seq / SLim	Sum	Compliance
Scenario 1	Primary Tx	WWAN	0.5233	0.5496	PASS
	Secondary Tx	Bluetooth	0.0262		
Scenario 2	Primary Tx	WWAN	0.5233	0.9203	PASS
	Secondary Tx	WLAN	0.3969		
Scenario 3	Primary Tx	WWAN	0.5233	0.9465	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	Bluetooth	0.0262		
Scenario 4	Primary Tx	WWAN	0.5233	0.9203	PASS
	Secondary Tx	WiMAX	0.3969		
Scenario 5	Primary Tx	WWAN	0.5233	0.9465	PASS
	Secondary Tx	WiMAX	0.3969		
	Secondary Tx	Bluetooth	0.0262		
Scenario 6	Primary Tx	WWAN	0.5233	0.9203	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	WiMAX			
Scenario 7	Primary Tx	WWAN	0.5233	0.9465	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	WiMAX			
	Secondary Tx	Bluetooth	0.0262		

b) Simultaneous Exposure according to EN limits

Scenario	Combination		worst case Seq / SLim	Sum	Compliance
Scenario 1	Primary Tx	WWAN	0.5757	0.6019	PASS
	Secondary Tx	Bluetooth	0.0262		
Scenario 2	Primary Tx	WWAN	0.5757	0.9726	PASS
	Secondary Tx	WLAN	0.3969		
Scenario 3	Primary Tx	WWAN	0.5757	0.9988	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	Bluetooth	0.0262		
Scenario 4	Primary Tx	WWAN	0.5757	0.9726	PASS
	Secondary Tx	WiMAX	0.3969		
Scenario 5	Primary Tx	WWAN	0.5757	0.9988	PASS
	Secondary Tx	WiMAX	0.3969		
	Secondary Tx	Bluetooth	0.0262		
Scenario 6	Primary Tx	WWAN	0.5757	0.9726	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	WiMAX			
Scenario 7	Primary Tx	WWAN	0.5757	0.9988	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	WiMAX			
	Secondary Tx	Bluetooth	0.0262		

c) Simultaneous Exposure according to AUS/NZ limits

Scenario	Combination		worst case Seq / SLim	Sum	Compliance
Scenario 1	Primary Tx	WWAN	0.5757	0.6019	PASS
	Secondary Tx	Bluetooth	0.0262		
Scenario 2	Primary Tx	WWAN	0.5757	0.9726	PASS
	Secondary Tx	WLAN	0.3969		
Scenario 3	Primary Tx	WWAN	0.5757	0.9988	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	Bluetooth	0.0262		
Scenario 4	Primary Tx	WWAN	0.5757	0.9726	PASS
	Secondary Tx	WiMAX	0.3969		
Scenario 5	Primary Tx	WWAN	0.5757	0.9988	PASS
	Secondary Tx	WiMAX	0.3969		
	Secondary Tx	Bluetooth	0.0262		
Scenario 6	Primary Tx	WWAN	0.5757	0.9726	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	WiMAX			
Scenario 7	Primary Tx	WWAN	0.5757	0.9988	PASS
	Secondary Tx	WLAN	0.3969		
	Secondary Tx	WiMAX			
	Secondary Tx	Bluetooth	0.0262		

Annex B: Document History

Version	Applied Changes	Date of Release
	Initial Release	2010-09-16
A	Device type and kind of test item updated. References to MPE calculation / mobile exposure updated or corrected. additional standards added in section 3	2010-09-22
B	Calculation upgraded to collocation of WLAN and/or WiMAX antennas with up to 33 dBm EIRP (previously WLAN 23 dBm and WiMAX 27 dBm). This reduces the allowed EIRP of the WWAN module 850/900 MHz antenna for use according to EN and AUS requirements. FCC/IC EIRP limits remain unchanged.	2010-09-12

Annex C: Further Information

Glossary

DUT - Device under Test
EMF - Electromagnetic Fields
EUT - Equipment under Test
FCC - Federal Communication Commission
FCC ID - Company Identifier at FCC
HW - Hardware
IC - Industry Canada
Inv. No. - Inventory number
N/A - not applicable
S/N - Serial Number
SW - Software