2.2 MAXIMUM 850 GPRS SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 17:33:31	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0030.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	23.1°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	54.85
RELATIVE HUMIDITY:	49.7%	**CONDUCTIVITY:**	0.986
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.5°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	-3.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-14.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	32.29 V/m
TEST FREQUENCY:	848.8MHz	**SAR 1g:**	1.195 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.831 W/kg
CONVERSION FACTORS:	0.273 / 0.273 / 0.273	**SAR START:**	0.351 W/kg
TYPE OF MODULATION:	GMSK	**SAR END:**	0.343 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-2.28 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

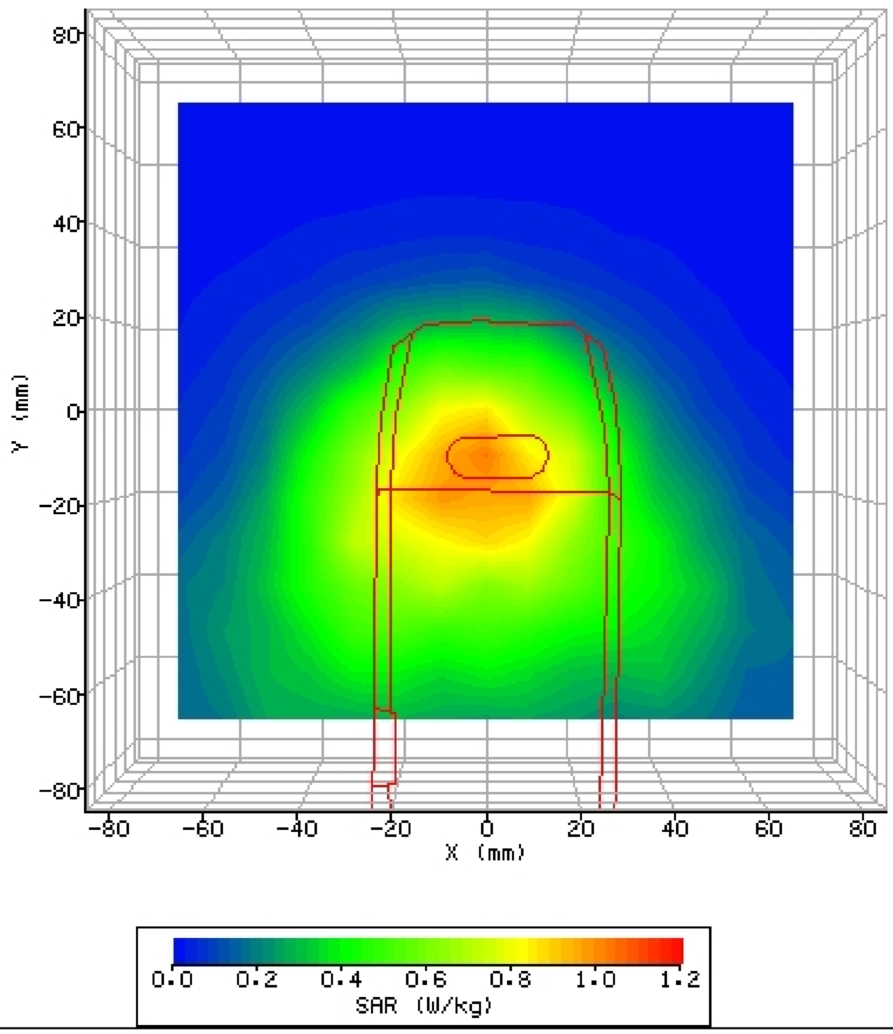


Figure 33: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 848.8MHz (850 GPRS Top Channel) with 14mm Separation – Host 3 used

2.2 MAXIMUM 1900 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 19:33:20	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0031.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.0°C	**LIQUID SIMULANT:**	1900 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	53.98
RELATIVE HUMIDITY:	66.7%	**CONDUCTIVITY:**	1.506
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.2°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	8.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-13.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	18.13 V/m
TEST FREQUENCY:	1880.0MHz	**SAR 1g:**	0.613 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.377 W/kg
CONVERSION FACTORS:	0.346 / 0.346 / 0.346	**SAR START:**	0.109 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.108 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-1.03 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

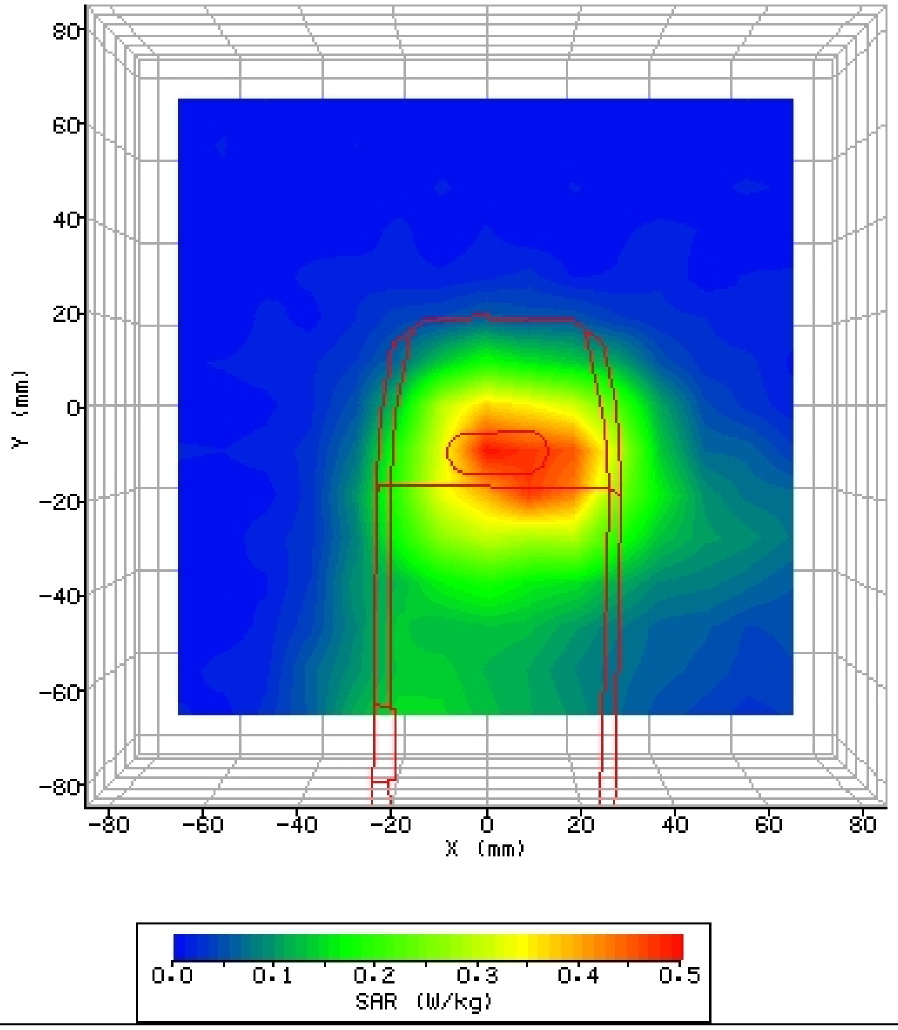


Figure 34: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 1880.0MHz (1900 GSM EDGE Middle Channel) with 10mm Separation – Host 1 used

2.2 MAXIMUM 1900 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	INPUT POWER DRIFT:	0.0dB
DATE / TIME:	27/10/2005 20:02:52	DUT BATTERY MODEL/NO:	N/A
FILENAME:	WS614714_0032.txt	PROBE SERIAL NUMBER:	170
AMBIENT TEMPERATURE:	22.3°C	LIQUID SIMULANT:	1900 Body
DEVICE UNDER TEST:	Novatel U730 Card	RELATIVE PERMITTIVITY:	53.98
RELATIVE HUMIDITY:	58.9%	CONDUCTIVITY:	1.506
PHANTOM S/NO:	CubePhantom.csv	LIQUID TEMPERATURE:	22.2°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	8.00 mm
DUT POSITION:	Rear Facing Phantom	MAX SAR Y-AXIS LOCATION:	-13.00 mm
ANTENNA CONFIGURATION:	Integral	MAX E FIELD:	17.36 V/m
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.555 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.356 W/kg
CONVERSION FACTORS:	0.346 / 0.346 / 0.346	SAR START:	0.103 W/kg
TYPE OF MODULATION:	8PSK	SAR END:	0.104 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	0.21 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	14/10/05
INPUT POWER LEVEL:	Max	EXTRAPOLATION:	poly4

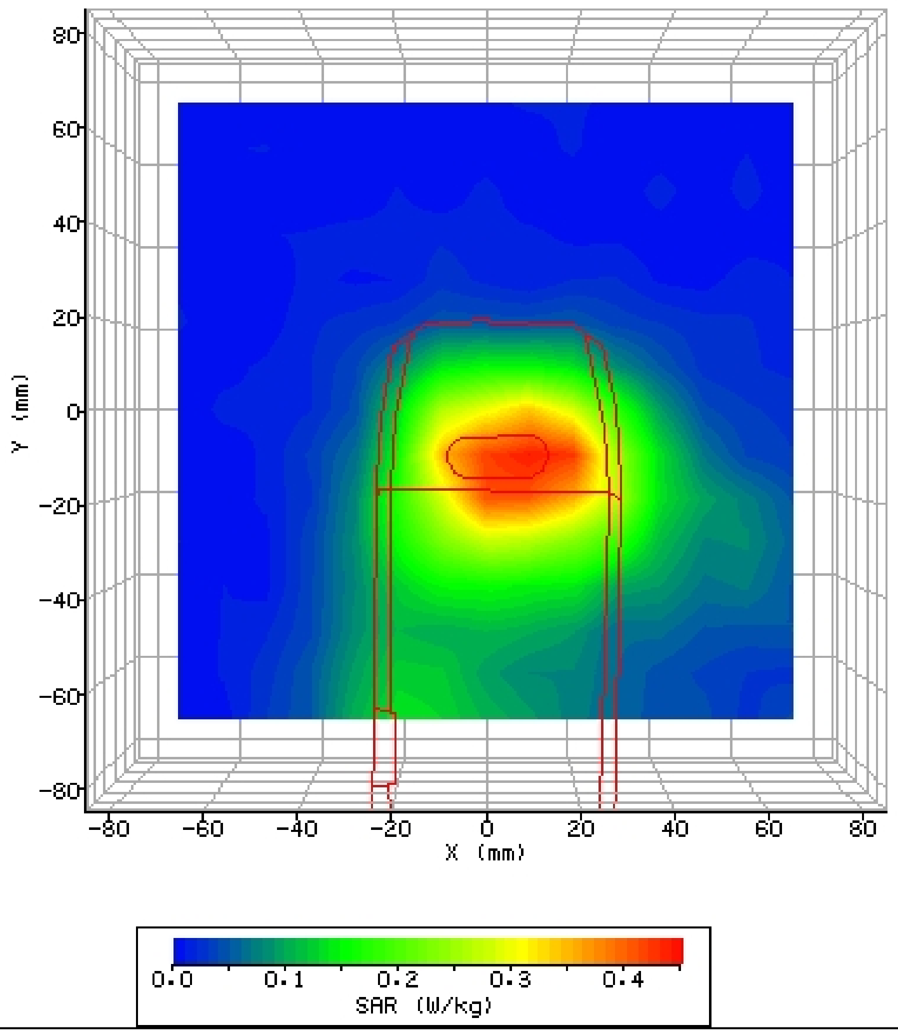


Figure 35: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 1850.2MHz (1900 GSM EDGE Bottom Channel) with 10mm Separation – Host 1 used

2.2 MAXIMUM 1900 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 20:26:18	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0033.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.1°C	**LIQUID SIMULANT:**	1900 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	53.98
RELATIVE HUMIDITY:	53.7%	**CONDUCTIVITY:**	1.506
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.2°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	10.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-13.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	18.25 V/m
TEST FREQUENCY:	1909.8MHz	**SAR 1g:**	0.620 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.369 W/kg
CONVERSION FACTORS:	0.346 / 0.346 / 0.346	**SAR START:**	0.106 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.105 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-0.96 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

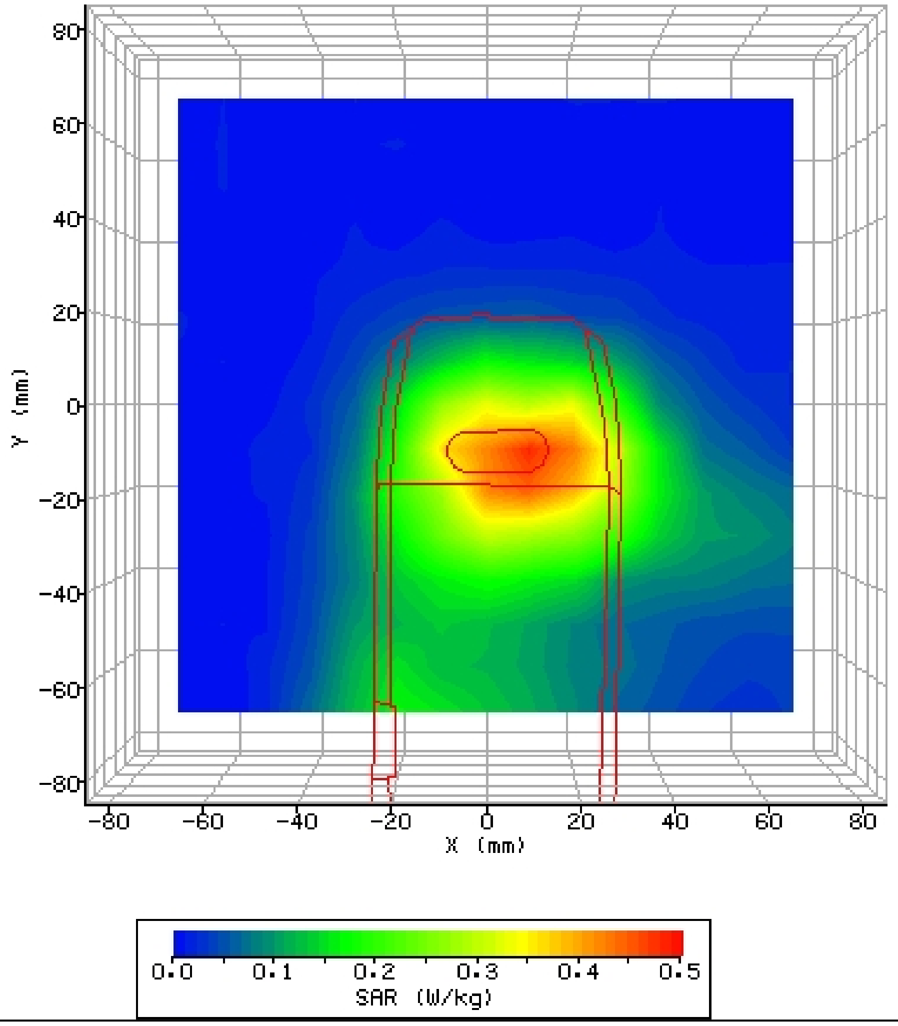


Figure 36: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 1909.8MHz (1900 GSM EDGE Top Channel) with 10mm Separation – Host 1 used

2.2 MAXIMUM 1900 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	28/10/2005 11:26:08	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0034.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.1°C	**LIQUID SIMULANT:**	1900 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	53.98
RELATIVE HUMIDITY:	49.2%	**CONDUCTIVITY:**	1.506
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.1°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	10.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-6.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	13.70 V/m
TEST FREQUENCY:	1909.8MHz	**SAR 1g:**	0.369 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.222 W/kg
CONVERSION FACTORS:	0.346 / 0.346 / 0.346	**SAR START:**	0.061 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.061 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	0.00 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

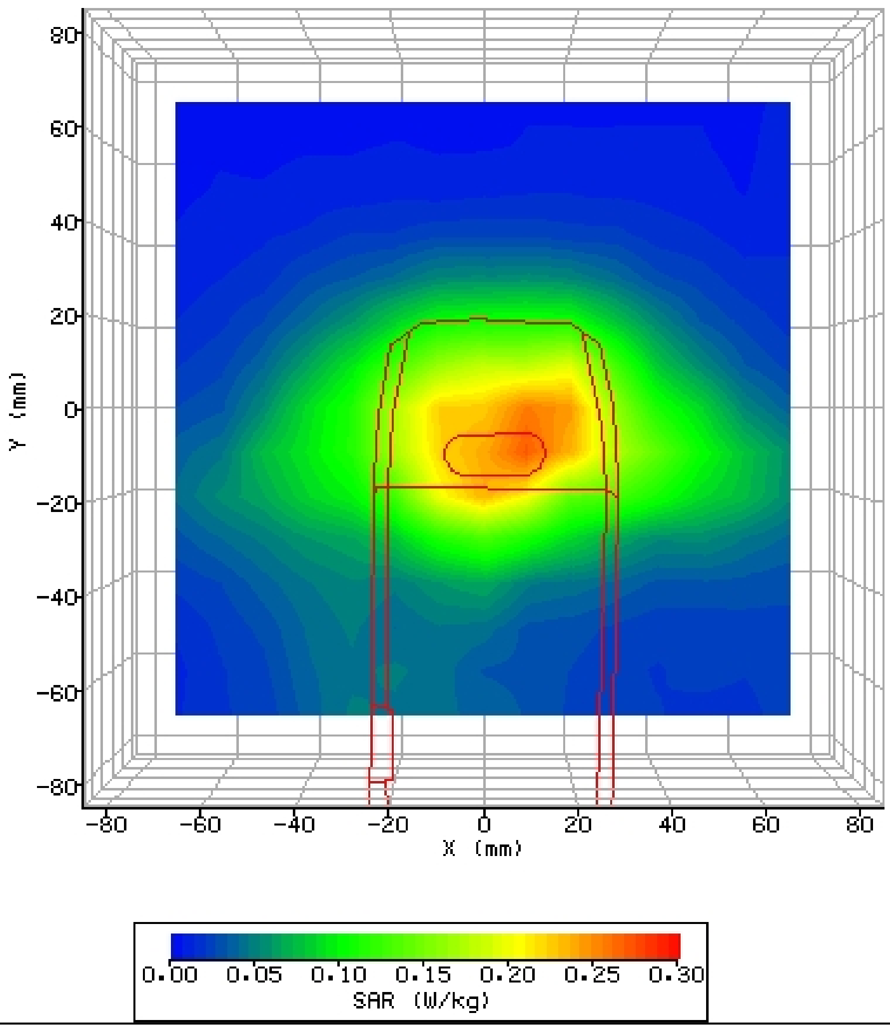


Figure 37: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 1909.8MHz (1900 GSM EDGE Top Channel) with 18mm Separation – Host 2 used

2.2 MAXIMUM 1900 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	INPUT POWER DRIFT:	0.0dB
DATE / TIME:	28/10/2005 09:30:10	DUT BATTERY MODEL/NO:	N/A
FILENAME:	WS614714_0035.txt	PROBE SERIAL NUMBER:	170
AMBIENT TEMPERATURE:	21.8°C	LIQUID SIMULANT:	1900 Body
DEVICE UNDER TEST:	Novatel U730 Card	RELATIVE PERMITTIVITY:	53.98
RELATIVE HUMIDITY:	47.6%	CONDUCTIVITY:	1.506
PHANTOM S/NO:	CubePhantom.csv	LIQUID TEMPERATURE:	22.1°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	21.00 mm
DUT POSITION:	Rear Facing Phantom	MAX SAR Y-AXIS LOCATION:	-16.00 mm
ANTENNA CONFIGURATION:	Integral	MAX E FIELD:	13.84 V/m
TEST FREQUENCY:	1909.8MHz	SAR 1g:	0.335 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.196 W/kg
CONVERSION FACTORS:	0.346 / 0.346 / 0.346	SAR START:	0.059 W/kg
TYPE OF MODULATION:	8PSK	SAR END:	0.057 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-3.28 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	14/10/05
INPUT POWER LEVEL:	Max	EXTRAPOLATION:	poly4

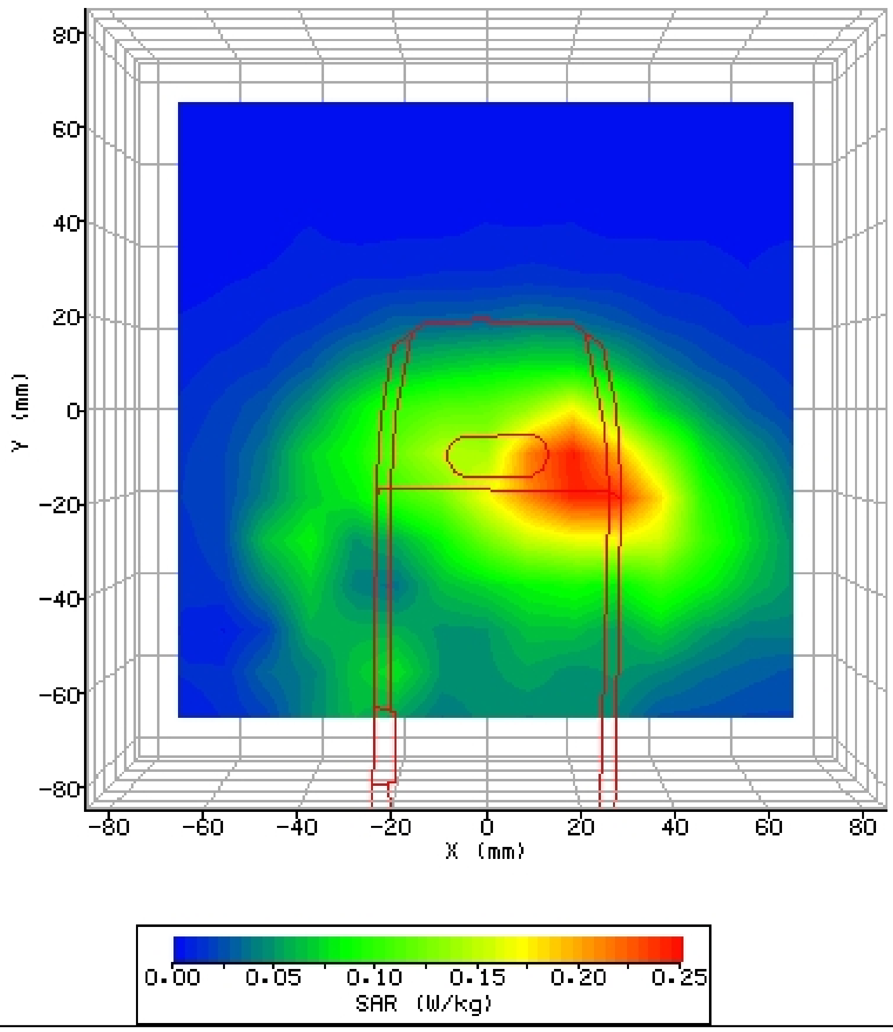


Figure 38: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 1909.8MHz (1900 GSM EDGE Top Channel) with 14mm Separation – Host 3 used

2.2 MAXIMUM 850 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 14:15:43	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0036.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.8°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	54.85
RELATIVE HUMIDITY:	50.1%	**CONDUCTIVITY:**	0.986
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.5°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	-1.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-7.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	20.74 V/m
TEST FREQUENCY:	836.4MHz	**SAR 1g:**	0.497 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.307 W/kg
CONVERSION FACTORS:	0.273 / 0.273 / 0.273	**SAR START:**	0.109 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.110 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	1.50 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

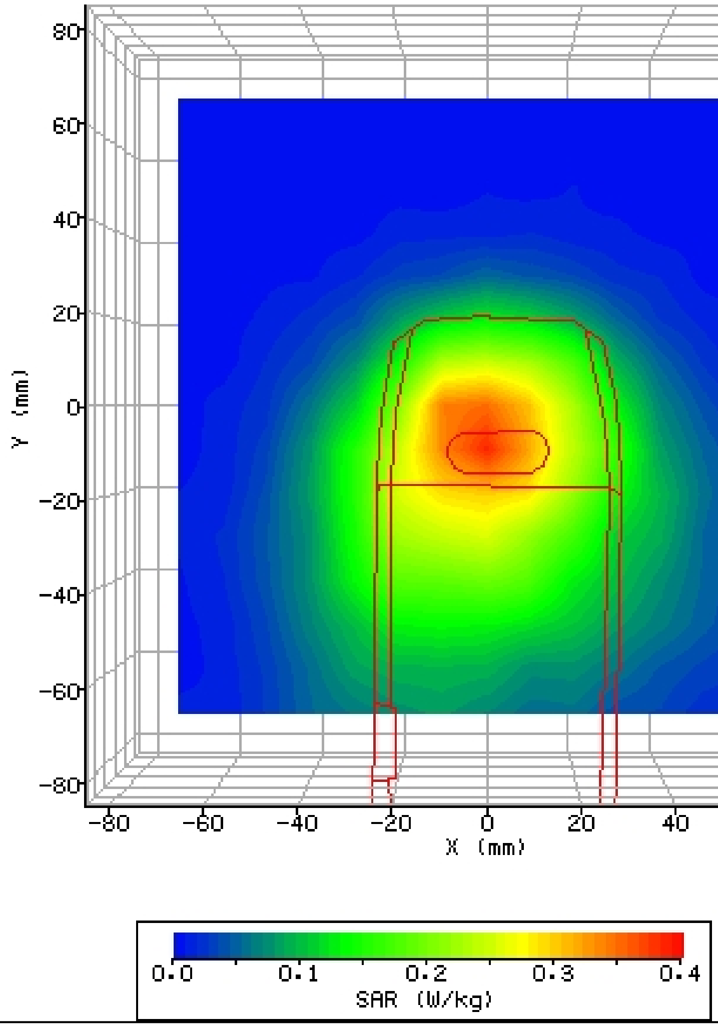


Figure 39: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 836.4MHz (850 GSM EDGE Middle Channel) with 10mm Separation – Host 1 used

2.2 MAXIMUM 850 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 14:40:05	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0037.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.6°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	54.85
RELATIVE HUMIDITY:	48.7%	**CONDUCTIVITY:**	0.986
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.5°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	2.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-4.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	19.08 V/m
TEST FREQUENCY:	824.2MHz	**SAR 1g:**	0.411 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.277 W/kg
CONVERSION FACTORS:	0.273 / 0.273 / 0.273	**SAR START:**	0.096 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.098 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	1.60 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

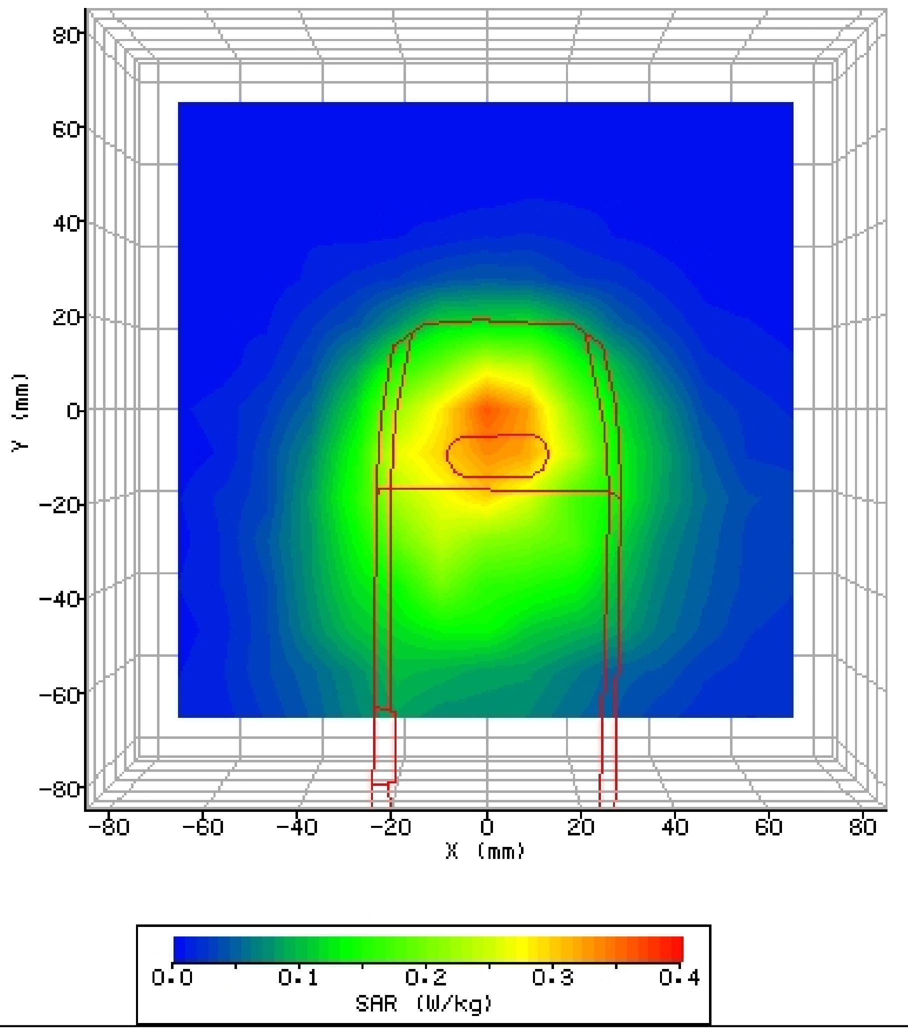


Figure 40: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 824.2MHz (850 GSM EDGE Bottom Channel) with 10mm Separation – Host 1 used

2.2 MAXIMUM 850 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 15:07:02	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0038.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.3°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	54.85
RELATIVE HUMIDITY:	45.3%	**CONDUCTIVITY:**	0.986
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.5°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	1.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-7.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	21.88 V/m
TEST FREQUENCY:	848.8MHz	**SAR 1g:**	0.572 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.356 W/kg
CONVERSION FACTORS:	0.273 / 0.273 / 0.273	**SAR START:**	0.125 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.127 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	1.34 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

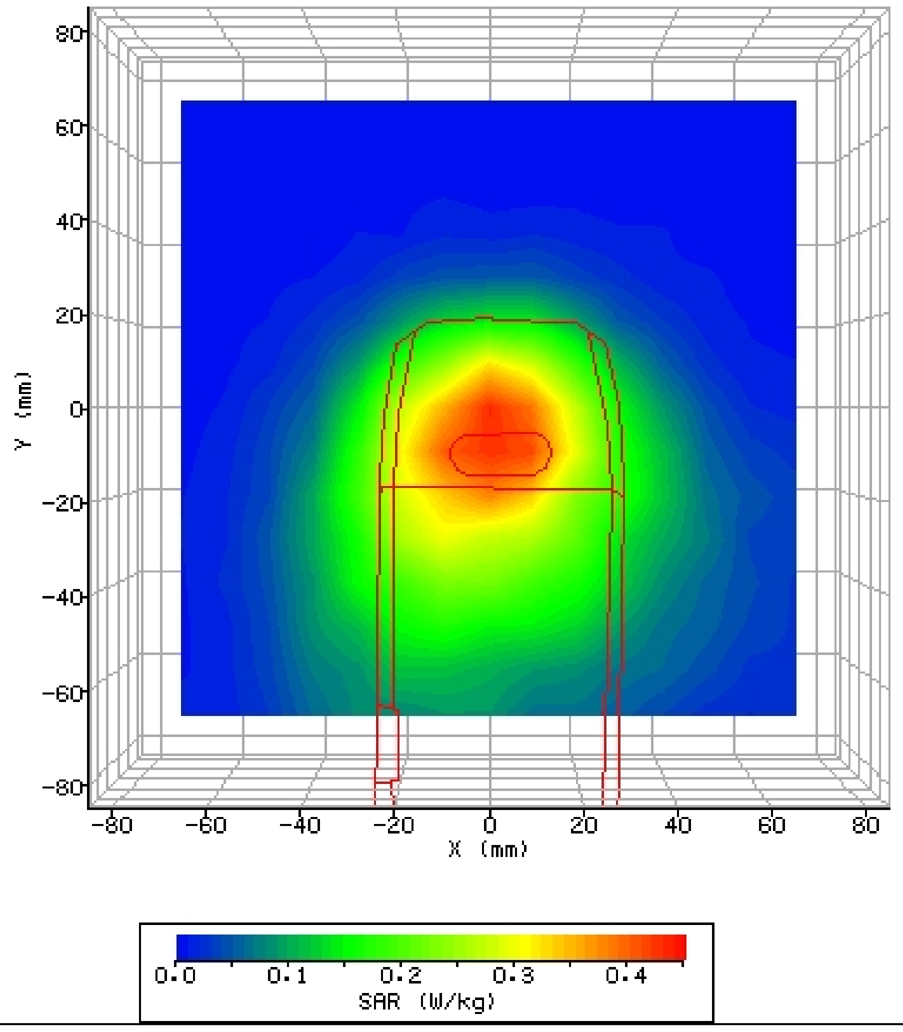


Figure 41: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 848.8MHz (850 GSM EDGE Top Channel) with 10mm Separation – Host 1 used

2.2 MAXIMUM 850 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	28/10/2005 12:44:45	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0039.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.7°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	54.85
RELATIVE HUMIDITY:	42.9%	**CONDUCTIVITY:**	0.986
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.4°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	8.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-2.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	23.54 V/m
TEST FREQUENCY:	848.8MHz	**SAR 1g:**	0.631 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.419 W/kg
CONVERSION FACTORS:	0.273 / 0.273 / 0.273	**SAR START:**	0.167 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.164 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-1.87 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

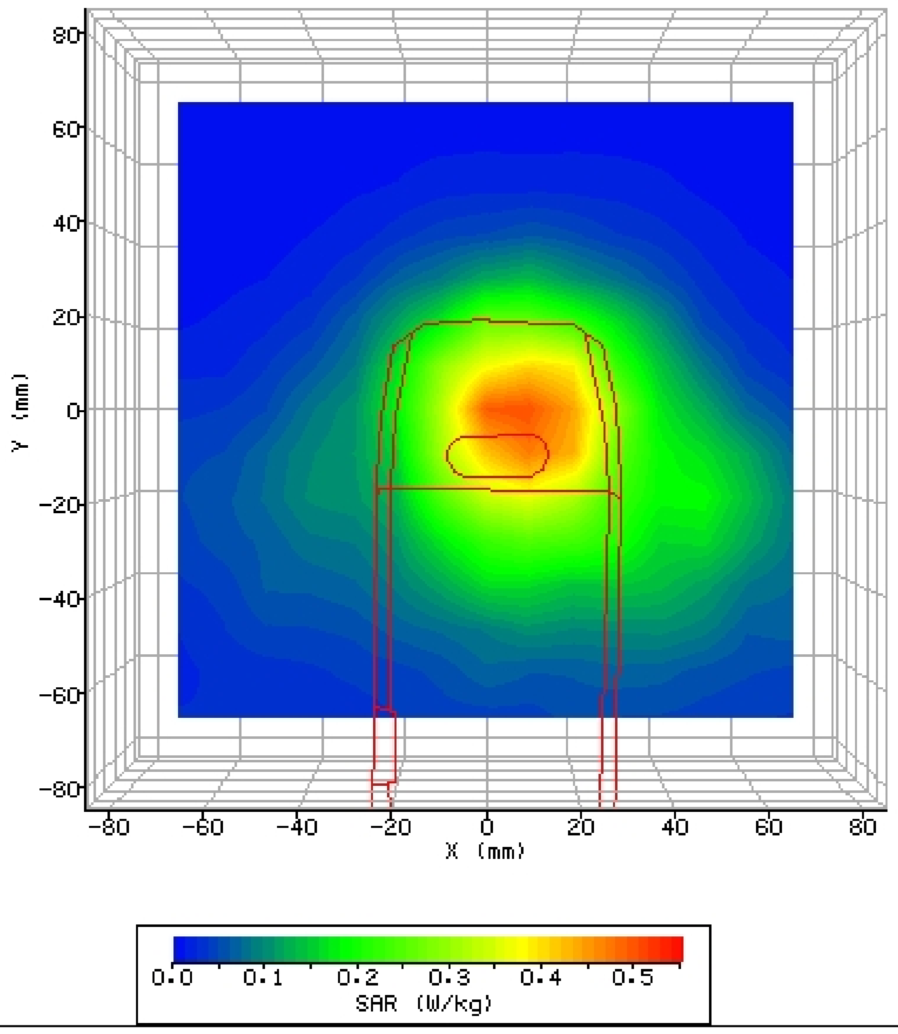


Figure 42: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 848.8MHz (850 GSM EDGE Top Channel) with 18mm Separation – Host 2 used

2.2 MAXIMUM 850 EDGE SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	27/10/2005 18:20:47	**DUT BATTERY MODEL/NO:**	N/A
FILENAME:	WS614714_0040.txt	**PROBE SERIAL NUMBER:**	170
AMBIENT TEMPERATURE:	22.1°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Novatel U730 Card	**RELATIVE PERMITTIVITY:**	54.85
RELATIVE HUMIDITY:	43.5%	**CONDUCTIVITY:**	0.986
PHANTOM S/NO:	CubePhantom.csv	**LIQUID TEMPERATURE:**	22.4°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	-10.00 mm
DUT POSITION:	Rear Facing Phantom	**MAX SAR Y-AXIS LOCATION:**	-7.00 mm
ANTENNA CONFIGURATION:	Integral	**MAX E FIELD:**	19.90 V/m
TEST FREQUENCY:	848.8MHz	**SAR 1g:**	0.462 W/kg
AIR FACTORS:	406 / 385 / 409	**SAR 10g:**	0.318 W/kg
CONVERSION FACTORS:	0.273 / 0.273 / 0.273	**SAR START:**	0.127 W/kg
TYPE OF MODULATION:	8PSK	**SAR END:**	0.127 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-0.07 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	14/10/05
INPUT POWER LEVEL:	Max	**EXTRAPOLATION:**	poly4

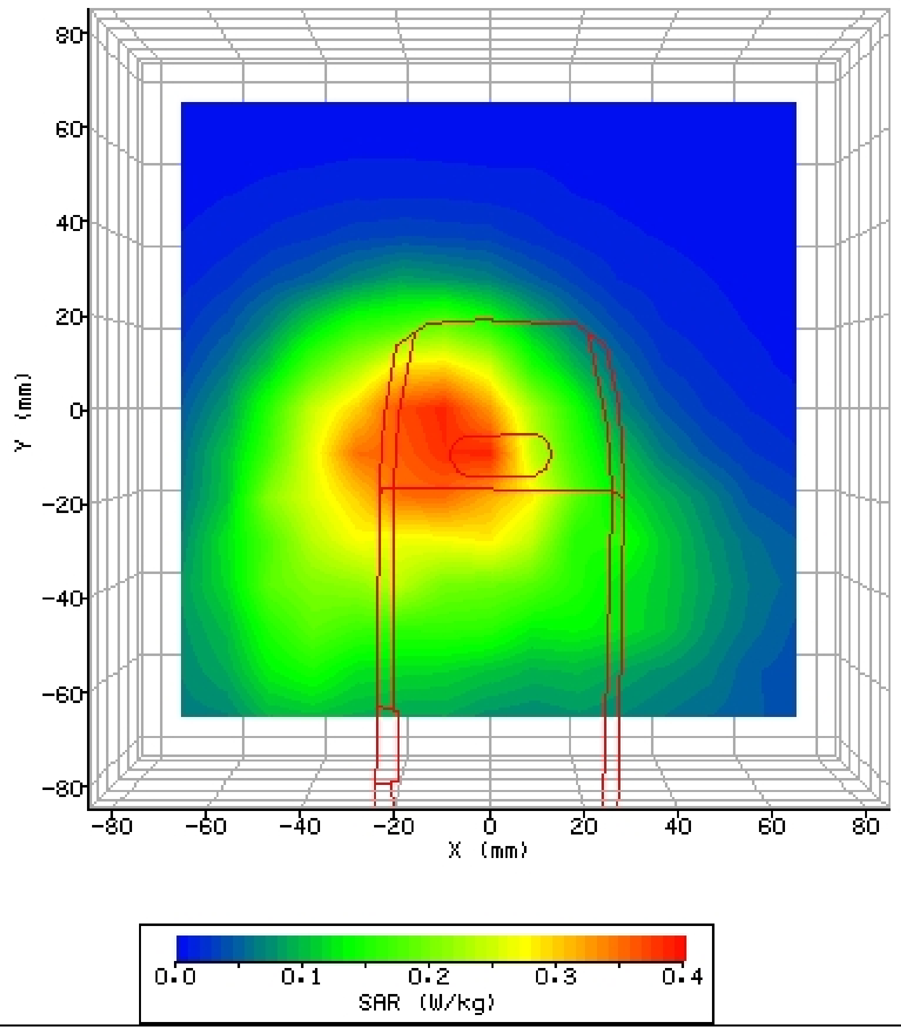


Figure 43: SAR Body Testing Results for the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position; Tested at 848.8MHz (850 GSM EDGE Top Channel) with 14mm Separation – Host 3 used

SECTION 3

TEST EQUIPMENT

3.1 TEST EQUIPMENT

The following test equipment was used at BABT:

INSTRUMENT DESCRIPTION	MANUFACTURER	MODEL TYPE	TEST EQUIPMENT NO.	CALIBRATION DATES	
Bench-top Robot	Mitsubishi	RV-E2	156	N/A	N/A
Fast Probe Amplifier	IndexSAR Ltd.	IFA-010	1557	N/A	N/A
Side Bench 2	IndexSAR Ltd.	IXM-030	1571	N/A	N/A
Upright Bench 1	IndexSAR Ltd.	SARA2 system	1568	N/A	N/A
SAR Probe	IndexSAR Ltd.	IXP-050	1555	15/01/2005	15/01/2006
Radio Communication Tester	Rohde & Schwarz	CMU 200	442	03/12/2004	03/12/2005
Signal Generator	Hewlett Packard	E4422A	61	15/02/2005	15/02/2006
Power Meter	Rohde & Schwarz	NRV	52	02/06/2005	02/06/2006
Spectrum Analyzer	Hewlett Packard	8566A	108	25/01/2005	25/01/2006
RF Pre-Amplifier	IndexSAR Ltd.	0.8-3G	2415	11/05/2005	11/05/2006
Bi-Directional Coupler	Krytar	1850	58	N/A	N/A
20dB Attenuator	Narda	766F-10	483	31/05/2005	31/05/2006
Hygrometer	Rotronic	I-1000	2783	01/06/2005	01/06/2006
Digital Thermometer	Digitron	T208	64	18/10/2005	18/10/2006
Thermocouple	Rohde & Schwarz	K	65	18/10/2005	18/10/2006
835MHz Body TEM	BABT	Batch 3	N/A	21/10/2005	04/11/2005
1900MHz Body TEM	BABT	Batch 2	N/A	21/10/2005	04/11/2005
844.4MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	27/10/2005	27/10/2005
1883.6MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	27/10/2005	27/10/2005
844.4MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	28/10/2005	28/10/2005
1883.6MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	28/10/2005	28/10/2005
844.4MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	29/10/2005	29/10/2005
1883.6MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	29/10/2005	29/10/2005
Flat Phantom 2mm Side	IndexSAR Ltd.	HeadBox01	1563	N/A	N/A
200mm Cube Box Phantom	IndexSAR Ltd.	IXB-070	1565	N/A	N/A
Dipole Positioner - Plastic	IndexSAR Ltd.	IXH-020	1584	N/A	N/A
Dipole Positioner - Foam	IndexSAR Ltd.	IXH-010	1586	N/A	N/A
Scissor Jack Base	IndexSAR Ltd.	IXB-030	1576	N/A	N/A
100mm Device Support	IndexSAR Ltd.	IXB-031	1572	N/A	N/A
200mm Device Support	IndexSAR Ltd.	IXB-032	1574	N/A	N/A

3.2 TEST SOFTWARE

The following software was used to control the BABT SARA2 System:

INSTRUMENT	VERSION NO.	DATE
SARA2 system	v.2.3.9 VPM	09/09/2005
Mitsubishi robot controller firmware revision	RV-E2 Version C9a	-
IFA-10 Probe amplifier	Version 2.5	-

3.3 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS

The fluid properties of the simulant fluids used during routine SAR evaluation meet the dielectric properties required by EN50361:2001 & OET Bulletin 65 (Edition 97-01).

The fluids were calibrated in our Laboratory and re-checked prior to any measurements being made against reference fluids stated in IEEE 1528-2003 of 0.9% NaCl (Salt Solution) at 23ºC and also for Dimethylsulphoxide (DMS) at 21ºC.

The fluids were made at BABT under controlled conditions from the following OET(65)c formulae and IEEE1528-2003. The composition of ingredients may have been modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation:

OET 65(c) Recipes

Ingredients	**Frequency (MHz)**									
(% by weight)	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

IEEE 1528 Recipes

Frequency (MHz)	**300**	**450**		**835**	**900**			**1450**	**1800**				**1900**		**1950**	**2000**	**2100**		**2450**		**3000**
Recipe #	**1**	**1**	**3**	**1**	**1**	**2**	**3**	**1**	**1**	**2**	**2**	**3**	**1**	**2**	**4**	**1**	**1**	**2**	**2**	**3**	**1**
Ingredients (% by weight)																					
1,2-Propanediol						64.81															
Bactericide	0.19	0.19	0.5	0.1	0.1		0.5					0.5								0.5	
Diacetin			48.9				49.2					49.43								49.75	
DGBE								45.41	47	13.84	44.92		44.92	13.84	45	50	50	7.99	7.99		7.99
HEC	0.98	0.98		1	1																
NaCl	5.95	3.95	1.7	1.45	1.48	0.79	1.1	0.67	0.36	0.35	0.18	0.64	0.18	0.35				0.16	0.16		0.16
Sucrose	55.32	56.32		57	56.5																
Triton X-100										30.45				30.45				19.97	19.97		19.97
Water	37.56	38.56	48.9	40.45	40.92	34.4	49.2	53.82	52.64	55.36	54.9	49.43	54.9	55.36	55	50	50	71.88	71.88	49.75	71.88
Measured dielectric parameters																					
ε_r'	46	43.4	44.3	41.6	41.2	41.8	42.7	40.9	39.3	41	40.4	39.2	39.9	41	40.1	37	36.8	41.1	40.3	39.2	37.9
σ (S/m)	0.86	0.85	0.9	0.9	0.98	0.97	0.99	1.21	1.39	1.38	1.4	1.4	1.42	1.38	1.41	1.4	1.51	1.55	1.88	1.82	2.46
Temp. (°C)	22	22	20	22	22	22	20	22	22	21	22	20	21	21	20	22	22	20	20	20	20
Target dielectric parameters (Table 5-1)																					
ε_r'	45.3	43.5		41.5	41.5			40.5	40								39.8		39.2		38.5
σ (S/m)	0.87	0.87		0.9	0.97			1.2	1.4								1.49		1.8		2.4

3.3 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS

The dielectric properties of the tissue simulant liquids used for the SAR testing at BABT are as follows:-

FLUID TYPE	FREQUENCY	RELATIVE PERMITTIVITY εr (e') TARGET	RELATIVE PERMITTIVITY εr (e') MEASURED	CONDUCTIVITY σ TARGET	CONDUCTIVITY σ MEASURED
BODY	835 MHz	55.0	54.85	1.05	0.986
BODY	1900 MHz	53.3	53.98	1.52	1.506

3.4 TEST CONDITIONS

TEST LABORATORY CONDITIONS

Ambient Temperature: Within +15°C to +35°C at 20% RH to 75% RH.
The actual Temperature during the testing ranged from 21.8°C to 23.3°C.
The actual Humidity during the testing ranged from 42.9% to 66.7% RH.

TEST FLUID TEMPERATURE RANGE

FREQUENCY	835 MHz	1900 MHz
BODY / HEAD FLUID	BODY	BODY
MIN TEMPERATURE (°C)	22.30	22.10
MAX TEMPERATURE (°C)	22.50	22.40

SAR DRIFT

The SAR Drift was within acceptable limits during scans. The maximum SAR Drift, drift due to the handset electronics, was recorded as -7.55% (-0.340dB) for all of the testing. The value -7.55% has been included in the measurement uncertainty budget.

3.5 MEASUREMENT UNCERTAINTY

ERROR SOURCES	EN 50361 Description (Subclause)	Uncertainty (%)	Probability Distribution	Divisor	ci	ci^2	Standard Uncertainty (%)	Stand Uncert^2	(Stand Uncert^2) X (ci^2)
Measurement Equipment									
Calibration	7.2.1.1	10	Normal	2.00	1	1	5.00	25.00	25.00
Isotropy	7.2.1.2	10.6	Rectangular	1.73	1	1	6.12	37.45	37.45
Linearity	7.2.1.3	2.92	Rectangular	1.73	1	1	1.69	2.84	2.84
Probe Stability	-	2.46	Rectangular	1.73	1	1	1.42	2.02	2.02
Detection limits	7.2.1.4	0	Rectangular	1.73	1	1	0.00	0.00	0.00
Boundary effect	7.2.1.5	1.7	Rectangular	1.73	1	1	0.98	0.96	0.96
Measurement device	7.2.1.6	0	Normal	1.00	1	1	0.00	0.00	0.00
Response time	7.2.1.7	0	Normal	1.00	1	1	0.00	0.00	0.00
Noise	7.2.1.8	0	Normal	1.00	1	1	0.00	0.00	0.00
Integration time	7.2.1.9	2.3	Normal	1.00	1	1	2.30	5.29	5.29
Mechanical constraints									
Scanning system	7.2.2.1	0.57	Rectangular	1.73	1	1	0.33	0.11	0.11
Phantom shell	7.2.2.2	1.43	Rectangular	1.73	1	1	0.83	0.68	0.68
Matching between probe and phantom	7.2.2.3	2.86	Rectangular	1.73	1	1	1.65	2.73	2.73
Positioning of the phone 'Y' Co-ordinate	7.2.2.4	1.5	Normal	1.00	1	1	1.50	2.25	2.25
Positioning of the phone 'Z' Co-ordinate	7.2.2.4	1.73	Normal	1.00	1	1	1.73	2.99	2.99
Physical Parameters									
Liquid conductivity (deviation from target)	7.2.3.2	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Liquid conductivity (measurement error)	7.2.3.2	15.3	Rectangular	1.73	0.5	0.25	8.83	78.03	19.51
Liquid permittivity (deviation from target)	7.2.3.3	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Liquid permittivity (measurement error)	7.2.3.3	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Drifts in output power of the phone, probe, temperature and humidity	7.2.3.4	7.55	Rectangular	1.73	1	1	4.36	19.00	19.00
Perturbation by the environment	7.2.3.5	3	Rectangular	1.73	1	1	1.73	3.00	3.00
Post-Processing									
SAR interpolation and extrapolation	7.2.4.1	2.4	Rectangular	1.73	1	1	1.39	1.92	1.92
Maximum SAR evaluation	7.2.4.2	2.4	Rectangular	1.73	1	1	1.39	1.92	1.92
Combined standard uncertainty	11.57						**Total**		133.92
Expanded uncertainty = (confidence interval of 95 %)	**23.15**	**%** (Using a Coverage Factor of K=2)							

SECTION 4

PHOTOGRAPHS

4.1 TEST POSITIONAL PHOTOGRAPHS

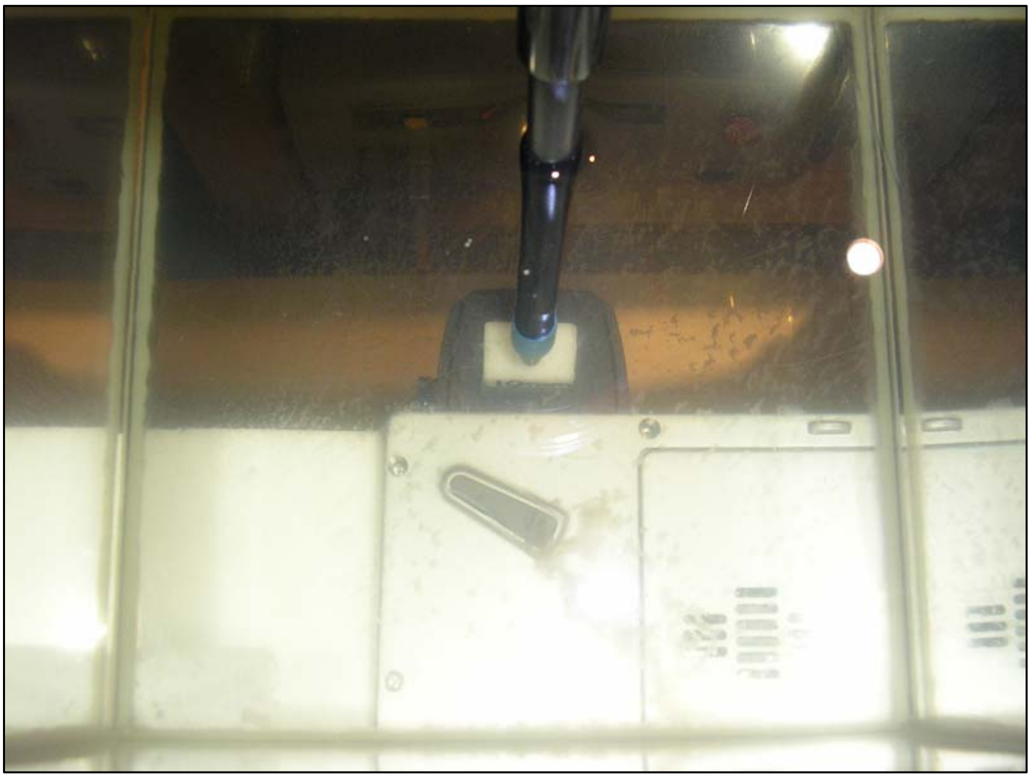


Figure 44: Positional Photograph of the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position using Host 1 – Averatec 6200 Series; 10mm Separation Distance

Figure 45: Positional Photograph of the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position using Host 1 – Averatec 6200 Series; 10mm Separation Distance

4.1 TEST POSITIONAL PHOTOGRAPHS

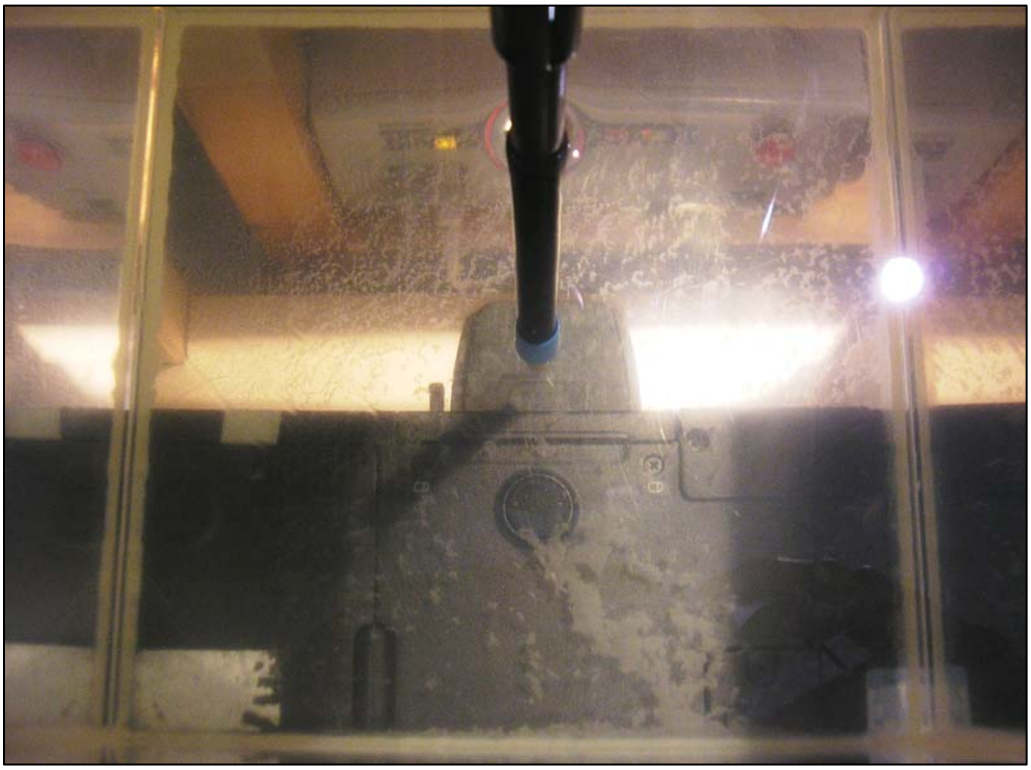


Figure 46: Positional Photograph of the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position using Host 2 – Dell Inspiron 9300; 18mm Separation Distance

Figure 47: Positional Photograph of the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position using Host 2 – Dell Inspiron 9300; 18mm Separation Distance

4.1 TEST POSITIONAL PHOTOGRAPHS

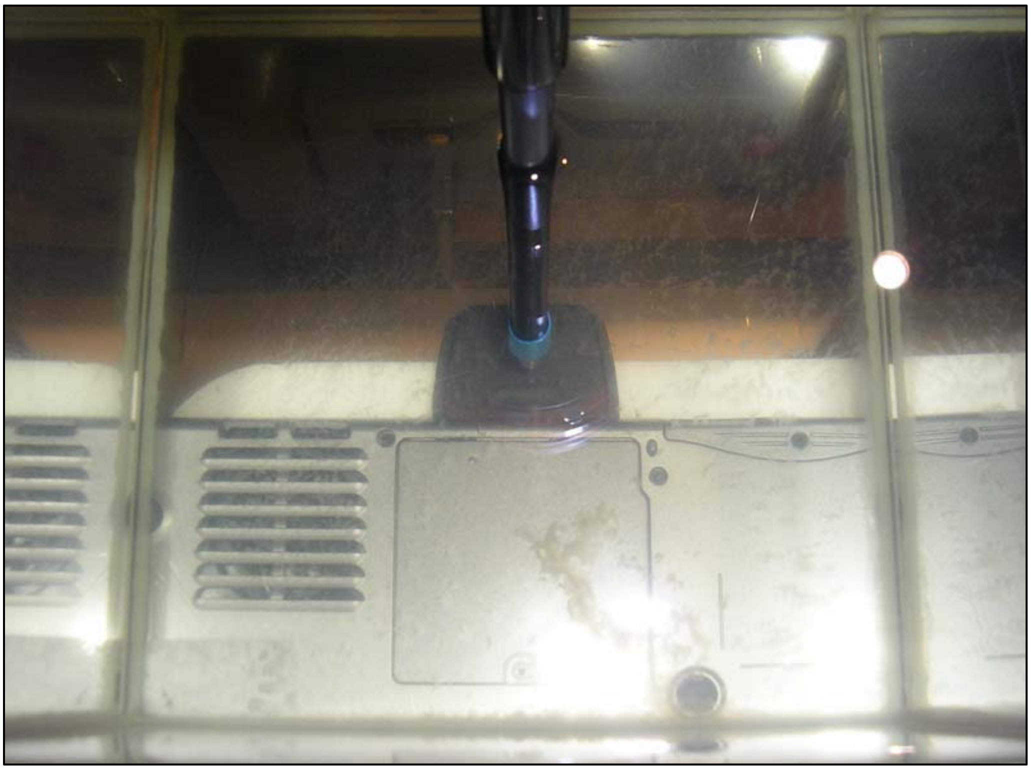


Figure 48: Positional Photograph of the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position using Host 3 – Dell Latitude D600; 14mm Separation Distance

Figure 49: Positional Photograph of the Novatel U730 Wireless PCMCIA Card in Rear Facing Phantom Position using Host 3 – Dell Latitude D600; 14mm Separation Distance

4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Figure 50: Front View of the U730 Wireless PCMCIA Card

Figure 51: Rear View of the U730 Wireless PCMCIA Card

4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Figure 52: Front View of Host 1 – Averatec 6200 Series Laptop

Figure 53: Front (Opened) View of Host 1 – Averatec 6200 Series Laptop

4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Figure 54: Front View of Host 2 – Dell Inspiron 9300 Laptop

Figure 55: Front (Opened) View of Host 2 – Dell Inspiron 9300 Laptop

4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Figure 56: Front View of Host 3 – Dell Latitude D600 Laptop

Figure 57: Front (Opened) View of Host 3 – Dell Latitude D600 Laptop

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

0141
Group

This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

ANNEX A

PROBE CALIBRATION PROCEDURE

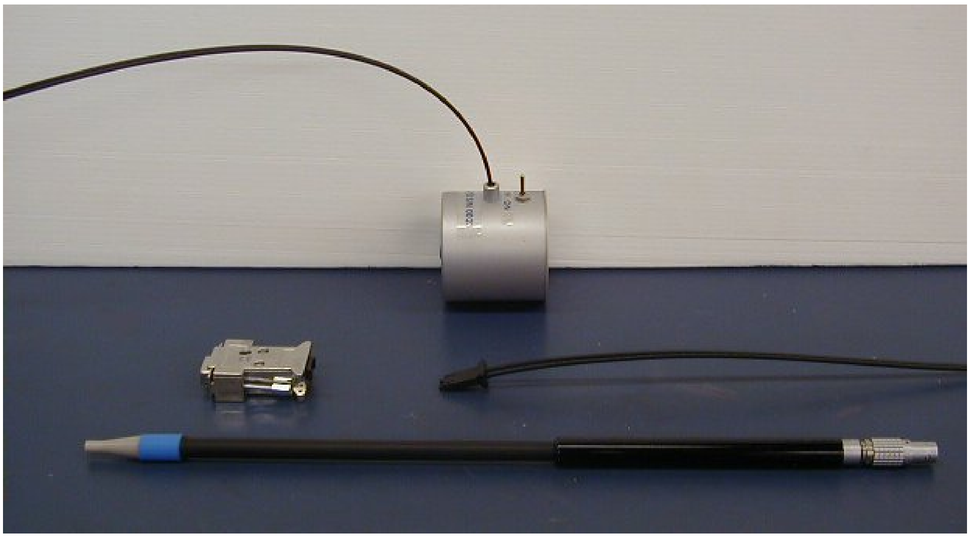
IMMERSIBLE SAR PROBE

CALIBRATION REPORT

Part Number: IXP – 050

S/N 0170

January 2005



IndexSAR Limited
Oakfield House
Cudworth Lane
Newdigate
Surrey RH5 5BG
Tel: +44 (0) 1306 632 870
Fax: +44 (0) 1306 631 834
e-mail: enquiries@indexsar.com

INTRODUCTION

This Report presents measured calibration data for a particular Indexsar SAR probe (S/N 0170) and describes the procedures used for characterisation and calibration.

Indexsar probes are characterised using procedures that, where applicable, follow the recommendations of CENELEC [1] and IEEE [2] standards. The procedures incorporate techniques for probe linearisation, isotropy assessment and determination of liquid factors (conversion factors). Calibrations are determined by comparing probe readings with analytical computations in canonical test geometries (waveguides) using normalised power inputs.

Each step of the calibration procedure and the equipment used is described in the sections below.

CALIBRATION PROCEDURE

1. Objectives

The calibration process comprises three stages
1) Determination of the channel sensitivity factors which optimise the probe's overall rotational isotropy in 1800MHz brain fluid
2) At each frequency of interest, application of these channel sensitivity factors to model the exponential decay of SAR in a waveguide fluid cell, and hence derive the liquid conversion factors at that frequency
3) Determination of the effective tip radius and angular offset of the X channel which together optimise the probe's spherical isotropy in 900MHz brain fluid

2. Probe Output

The probe channel output signals are linearised in the manner set out in Refs [1] and [2]. The following equation is utilized for each channel:

$$U_{lin} = U_{o/p} + U_{o/p}{}^{2} / DCP \qquad (1)$$

where U_{lin} is the linearised signal, $U_{o/p}$ is the raw output signal in voltage units and DCP is the diode compression potential in similar voltage units.

DCP is determined from fitting equation (1) to measurements of U_{lin} versus source feed power over the full dynamic range of the probe. The DCP is a characteristic of the Schottky diodes used as the sensors. For the IXP-050 probes with CW signals the DCP values are typically 0.10V (or 20 in the voltage units used by Indexsar software, which are V*200).

In turn, measurements of E-field are determined using the following equation (where output voltages are also in units of V*200):

$$E_{liq}{}^{2}\ (V/m) = U_{linx} * \text{Air Factor}_x * \text{Liq Factor}_x + U_{liny} * \text{Air Factor}_y * \text{Liq Factor}_y + U_{linz} * \text{Air Factor}_z * \text{Liq Factor}_z \qquad (3)$$

Here, "Air Factor" represents each channel's sensitivity, while "Liq Factor" represents the enhancement in signal level when the probe is immersed in tissue-simulant liquids at each frequency of interest.

CALIBRATION PROCEDURE

3. Selecting Channel Sensitivity Factors To Optimise Isotropic Response

After manufacture, the first stage of the calibration process is to balance the three channels' Air Factor values, thereby optimising the probe's overall axial response ("rotational isotropy").

To do this, an 1800MHz waveguide containing head-fluid simulant is selected. Like all waveguides used during probe calibration, this particular waveguide contains two distinct sections: an air-filled launcher section, and a liquid cell section, separated by a dielectric matching window designed to minimise reflections at the air-liquid interface.

The waveguide stands in an upright position and the liquid cell section is filled with 1800MHz brain fluid to within 10 mm of the open end. The depth of liquid ensures there is negligible radiation from the waveguide open top and that the probe calibration is not influenced by reflections from nearby objects.

During the measurement, a TE_{01} mode is launched into the waveguide by means of an N-type-to-waveguide adapter. The probe is then lowered vertically into the liquid until the tip is exactly 115mm above the centre of the dielectric window. This particular separation ensures that the probe is operating in a part of the waveguide where boundary corrections are not necessary.

Care must also be taken that the probe tip is centred while rotating.

The exact power applied to the input of the waveguide during this stage of the probe calibration is immaterial since only relative values are of interest while the probe rotates. However, the power must be sufficiently above the noise floor and free from drift.

The dedicated Indexsar calibration software rotates the probe in 10 degree steps about its axis, and at each position, an Indexsar 'Fast' amplifier samples the probe channels 500 times per second for 0.4 s. The raw $U_{o/p}$ data from each sample are packed into 10 bytes and transmitted back to the PC controller via an optical cable. U_{linx}, U_{liny} and U_{linz} are derived from the raw $U_{o/p}$ values and written to an Excel template.

Once data have been collected from a full probe rotation, the Air Factors are adjusted using a special Excel Solver routine to equalise the output from each channel and hence minimise the rotational isotropy. This automated approach to optimisation removes the effect of human bias.

Figure 5 represents the output from each diode sensor as a function of probe rotation angle. The directionality of the orthogonally-arranged sensors can be checked by analysing the data using dedicated Indexsar software, which displays the data in 3D format, a representative image of which is shown in Figure 3. The left-hand side of this diagram shows the individual channel outputs after linearisation (see above). The program uses these data to balance the channel outputs and then applies an optimisation process, which makes fine adjustments to the channel factors for optimum isotropic response.

CALIBRATION PROCEDURE

4. Determination Of Conversion ("Liquid") Factors At Each Frequency Of Interest

A lookup table of conversion factors for a probe allows a SAR value to be derived at the measured frequencies, and for either brain or body fluid-simulant.

The method by which the conversion factors are assessed is based on the comparison between measured and analytical rates of decay of SAR with height above a dielectric window. This way, not only can the conversion factors for that frequency/fluid combination be determined, but an allowance can also be made for the scale and range of boundary layer effects.

The theoretical relationship between the SAR at the cross-sectional centre of the lossy waveguide as a function of the longitudinal distance (*z*) from the dielectric separator is given by Equation 4:

$$SAR(z) = \frac{4\left(P_f - P_b\right)}{\rho ab\delta} e^{-2z/\delta} \quad (4)$$

Here, the density ρ is conventionally assumed to be 1000 kg/m^3, *ab* is the cross-sectional area of the waveguide, and P_f and P_b are the forward and reflected power inside the lossless section of the waveguide, respectively. The penetration depth δ (which is the reciprocal of the waveguide-mode attetion coefficient) is a property of the lossy liquid and is given by Equation (5).

$$\delta = \left[\mathrm{Re}\left\{ \sqrt{\left(\pi / a\right)^2 + j\omega\mu_o\left(\sigma + j\omega\varepsilon_o\varepsilon_r\right)} \right\} \right]^{-1} \quad (5)$$

where σ is the conductivity of the tissue-simulant liquid in S/m, ε_r is its relative permittivity, and ω is the radial frequency (rad/s). Values for σ and ε_r are obtained prior to each waveguide test using an Indexsar DiLine measurement kit, which uses the TEM method as recommended in [2]. σ and ε_r are both temperature- and fluid-dependent, so are best measured using a sample of the tissue-simulant fluid immediately prior to the actual calibration.

Wherever possible, all DiLine and calibration measurements should be made in the open laboratory at 22 $\pm$ 2.0^{o}C; if this is not possible, the values of σ and ε_r should reflect the actual temperature. Values employed for calibration are listed in the tables below.

By ensuring the liquid height in the waveguide is at least three penetration depths, reflections at the upper surface of the liquid are negligible. The power absorbed in the liquid is therefore determined solely from the waveguide forward and reflected power.

Different waveguides are used for 835/900MHz, 1800/1900MHz, 2450MHz and 5200/5800MHz measurements. Table A.1 of [1] can be used for designing calibration waveguides with a return loss greater than 20 dB at the most important frequencies used for personal wireless communications, and better than 15dB for frequencies

CALIBRATION PROCEDURE

4. Determination Of Conversion ("Liquid") Factors At Each Frequency Of Interest - continued

greater than 5GHz. Values for the penetration depth for these specific fixtures and tissue-simulating mixtures are also listed in Table A.1.

According to [1], this calibration technique provides excellent accuracy, with standard uncertainty of less than 3.6% depending on the frequency and medium. The calibration itself is reduced to power measurements traceable to a standard calibration procedure. The practical limitation to the frequency band of 800 to 5800 MHz because of the waveguide size is not severe in the context of compliance testing.

During calibration, the probe is lowered carefully until it is just touching the cross-sectional centre of the dielectric window. 200 samples are then taken and written to an Excel template file before moving the probe vertically upwards. This cycle is repeated 50 times. The vertical separation between readings is determined from practical considerations of the expected SAR decay rate, and range from 1mm steps at low frequency, through 0.5mm at 2450MHz, down to 0.2mm at 5GHz.

Once the data collection is complete, a Solver routine is run which optimises the measured-theoretical fit by varying the conversion factor, and the boundary correction size and range.

5. Measurement of Spherical Isotropy

The setup for measuring the probe's spherical isotropy is shown in Figure 2.

A box phantom containing 900MHz head fluid is irradiated by a vertically-polarised, tuned dipole, mounted to the side of the phantom on the robot's seventh axis. During calibration, the spherical response is generated by rotating the probe about its axis in 20 degree steps and changing the dipole polarisation in 10 degree steps.

By using the VPM technique discussed below, an allowance can also be made for the effect of E-field gradient across the probe's spatial extent. This permits values for the probe's effective tip radius and X-channel angular offset to be modelled until the overall spherical isotropy figure is optimised.

The dipole is connected to a signal generator and amplifier via a directional coupler and power meter. As with the determination of rotational isotropy, the absolute power level is not important as long as it is stable.

The probe is positioned within the fluid so that its sensors are at the same vertical height as the centre of the source dipole. The line joining probe to dipole should be perpendicular to the phantom wall, while the horizontal separation between the two should be small enough for VPM corrections to be applicable, without encroaching near the boundary layer of the phantom wall. VPM corrections require a knowledge of the fluid skin depth. This is measured during the calibration by recording the E-field strength while systematically moving the probe away from the dipole in 2mm steps over a 215mm range.

VPM (Virtual Probe Miniaturisation)

SAR probes with 3 diode-sensors in an orthogonal arrangement are designed to display an isotropic response when exposed to a uniform field. However, the probes are ordinarily used for measurements in non-uniform fields and isotropy is not

CALIBRATION PROCEDURE

5. Measurement of Spherical Isotropy - continued

assured when the field gradients are significant compared to the dimensions of the tip containing the three orthogonally-arranged dipole sensors.

It becomes increasingly important to assess the effects of field gradients on SAR probe readings when higher frequencies are being used. For Indexsar IXP-050 probes, which are of 5mm tip diameter, field gradient effects are minor at GSM frequencies, but are major above 5GHz. Smaller probes are less affected by field gradients and so probes, which are significantly less than 5mm diameter, would be better for applications above 5GHz.

The IndexSAR report IXS0223 describes theoretical and experimental studies to evaluate the issues associated with the use of probes at arbitrary angles to surfaces and field directions. Based upon these studies, the procedures and uncertainty analyses referred to in P1528 are addressed for the full range of probe presentation angles.

In addition, generalized procedures for correcting for the finite size of immersible SAR probes are developed. Use of these procedures enables application of schemes for virtual probe miniaturization (VPM) – allowing probes of a specific size to be used where physically-smaller probes would otherwise be required.

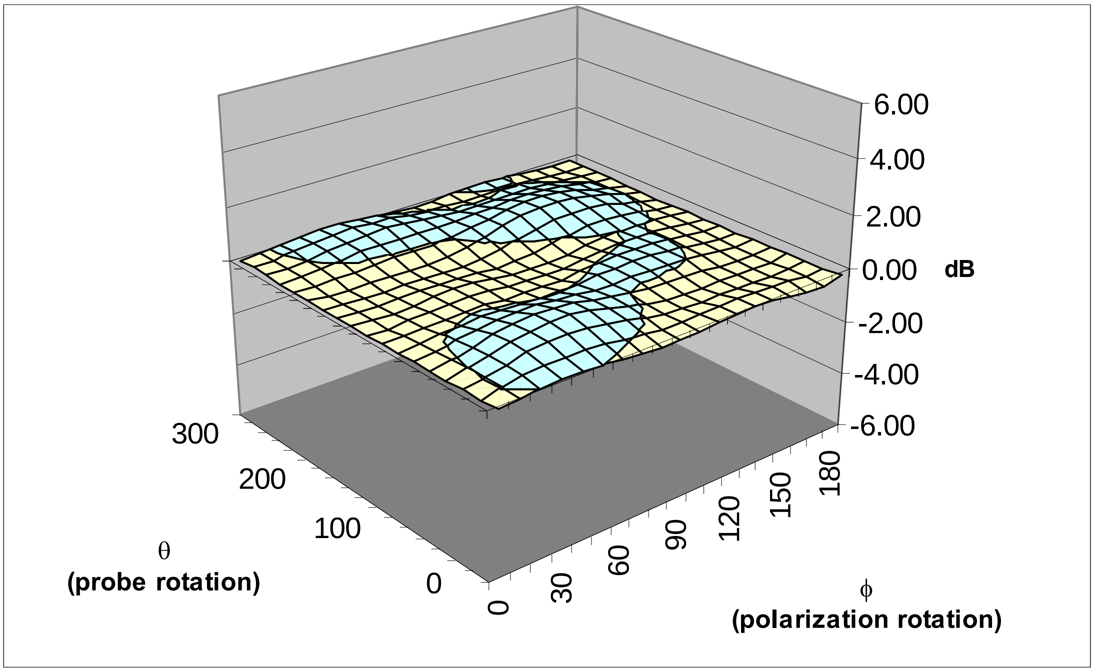
Given the typical dimensions of 3-channel SAR probes presently available, use of the VPM technique extends the satisfactory measurement range to higher frequencies.

CALIBRATION FACTORS MEASURED FOR PROBE S/N 0170

The probe was calibrated at 835, 900, 1800, 1900, 2450, 5200 and 5800 MHz in liquid samples representing both brain liquid and body fluid at these frequencies. The calibration was for CW signals only, and the axis of the probe was parallel to the direction of propagation of the incident field i.e. end-on to the incident radiation. The axial isotropy of the probe was measured by rotating the probe about its axis in 10 degree steps through 360 degrees in this orientation.

The reference point for the calibration is in the centre of the probe's cross-section at a distance of 2.7 mm from the probe tip in the direction of the probe amplifier. A value of 2.7 mm should be used for the tip to sensor offset distance in the software. The distance of 2.7mm for assembled probes has been confirmed by taking X-ray images of the probe tips (see Figure 8).

It is important that the diode compression point and air factors used in the software are the same as those quoted in the results tables, as these are used to convert the diode output voltages to a SAR value.



Surface Isotropy diagram of IXP-050 Probe S/N 0170 at 900MHz after VPM (rotational isotropy at side +/-0.09dB, spherical isotropy +/-0.44dB)

Probe tip radius	1.33
X Ch. Angle to red dot	1

CALIBRATION FACTORS MEASURED FOR PROBE S/N 0170

	Head		Body	
Frequency	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**
835	0.50	3.0	0.51	3.0
900	0.50	3.0	0.51	3.0
1800	0.69	1.6	0.60	1.9
1900	0.65	1.7	0.56	2.0
2450	0.39	3.0	0.43	3.0
5200	1.00	1.0	1.00	1.7
5800	1.00	1.0	1.00	1.8

SUMMARY OF CALIBRATION FACTORS FOR PROBE IXP-050 S/N 0170

Spherical isotropy measured at 900MHz	0.44	(+/-) dB

	X	Y	Z	
Air Factors	406	385	409	(V*200)
CW DCPs	20	20	20	(V*200)

Freq (MHz)	Axial Isotropy (+/- dB)		SAR ConvF (liq/air)		Notes
	Head	Body	Head	Body	
835	-	-	0.256	0.273	1,2
900	-	-	0.258	0.280	1,2
1800	0.09	-	0.305	0.331	1,2
1900	-	-	0.314	0.346	1,2
2450	-	-	0.360	0.412	1,2
5200	-	-	0.372	0.635	1,2
5800	-	-	0.343	0.589	1,2

Notes	
1)	Calibrations done at 22^{o}C +/-2^{o}C
2)	Waveguide calibration

PROBE SPECIFICATIONS

Indexsar probe 0170, along with its calibration, is compared with CENELEC and IEEE standards recommendations (Refs [1] and [2]) in the Tables below. A listing of relevant specifications is contained in the tables below:

Dimensions	S/N 0170	CENELEC [1]	IEEE [2]
Overall length (mm)	350	-	-
Tip length (mm)	10	-	-
Body diameter (mm)	12	-	-
Tip diameter (mm)	5.2	8	8
Distance from probe tip to dipole centers (mm)	2.7	-	-

Dynamic range	S/N 0170	CENELEC [1]	IEEE [2]
Minimum (W/kg)	0.01	<0.02	0.01
Maximum (W/kg) N.B. only measured to > 100 W/kg on representative probes	>100	>100	100

Isotropy (measured at 900MHz)	S/N 0170	CENELEC [1]	IEEE [2]
Axial rotation with probe normal to source (+/- dB)	0.09 Max (See table above)	0.5	0.25
Spherical isotropy covering all orientations to source (+/- dB)	0.44	1.0	0.50

Construction	Each probe contains three orthogonal dipole sensors arranged on a triangular prism core, protected against static charges by built-in shielding, and covered at the tip by PEEK cylindrical enclosure material. No adhesives are used in the immersed section. Outer case materials are PEEK and heat-shrink sleeving.
Chemical resistance	Tested to be resistant to glycol and alcohol containing simulant liquids but probes should be removed, cleaned and dried when not in use.

REFERENCES

[1] CENELEC, EN 50361, July 2001. Basic Standard for the measurement of specific absorption rate related to human exposure to electromagnetic fields from mobile phones.

[2] IEEE 1528, Recommended practice for determining the spatial-peak specific absorption rate (SAR) in the human body due to wireless communications devices: Experimental techniques.

FIGURES

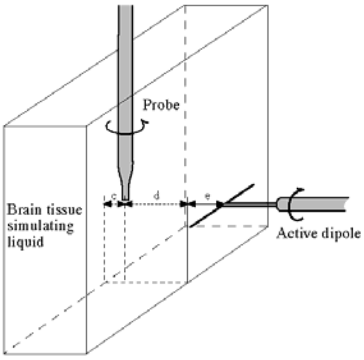


Figure 1. Spherical isotropy jig showing probe, dipole and box filled with simulated brain liquid (see Ref [2], Section A.5.2.1)

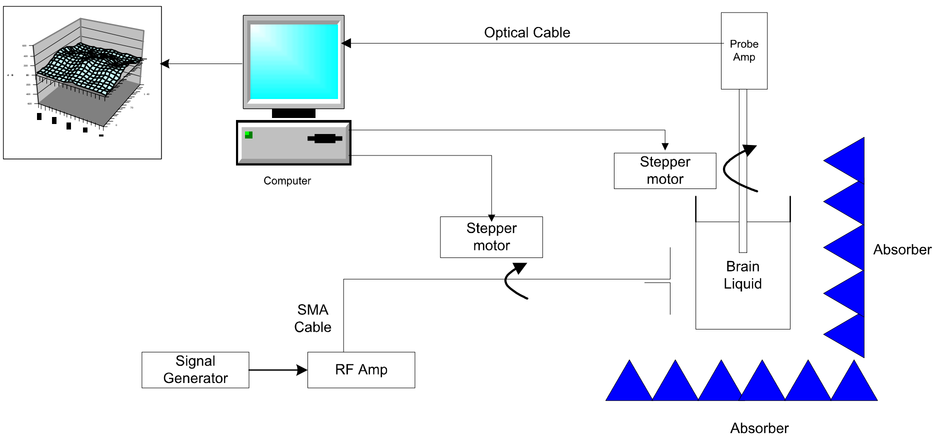


Figure 2. Schematic diagram of the test geometry used for isotropy determination

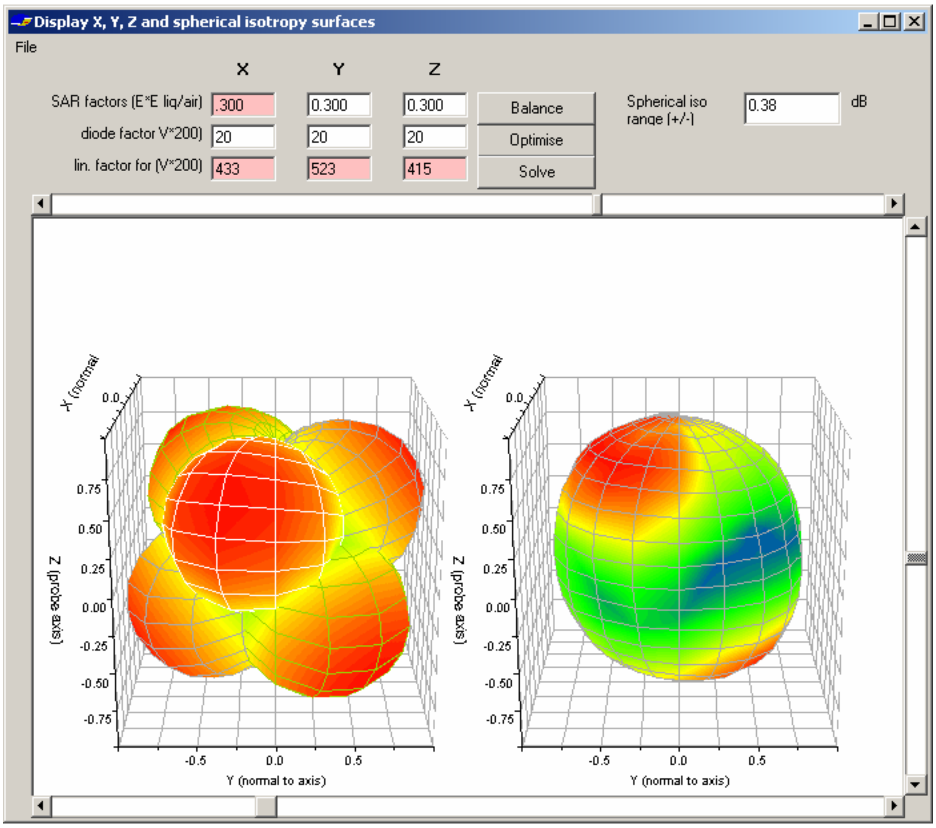


Figure 3. Graphical representation of a probe's response to fields applied from each direction. The diagram on the left shows the individual response characteristics of each of the three channels and the diagram on the right shows the resulting probe sensitivity in each direction. The colour range in the figure images the lowest values as blue and the maximum values as red. For the probe S/N 0170, this range is (+/-) 0.44 dB.

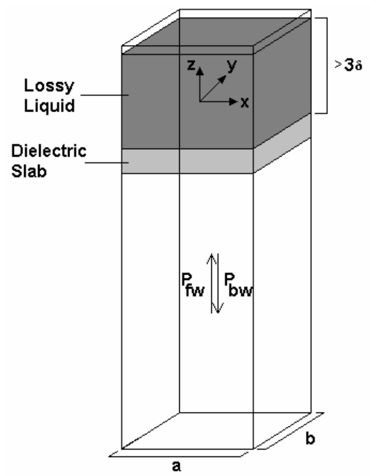


Figure 4. Geometry used for waveguide calibration (after Ref [2]. Section A.3.2.2)

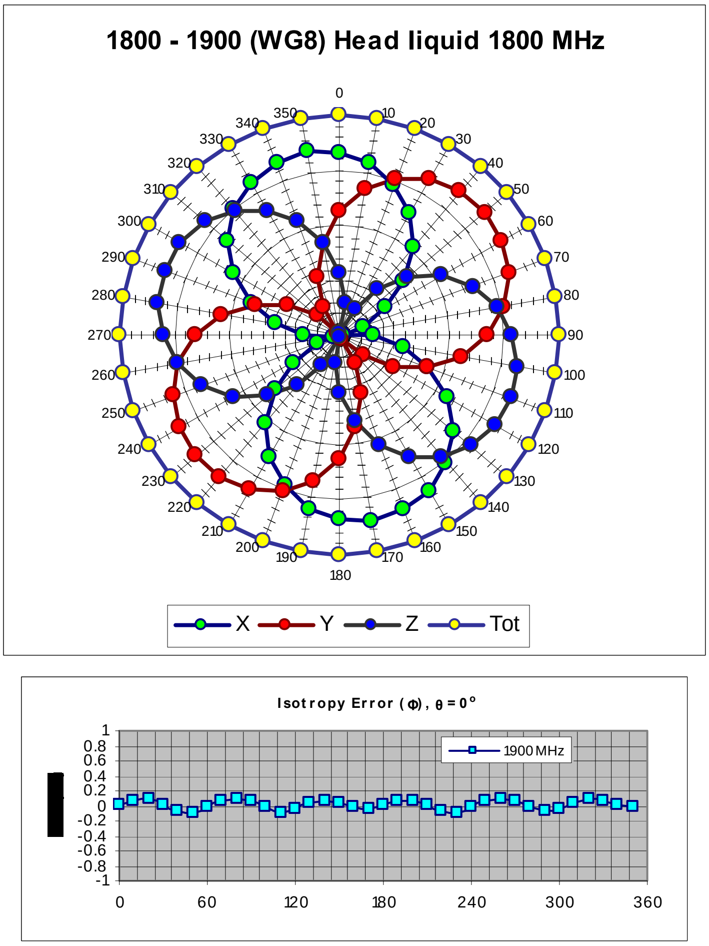
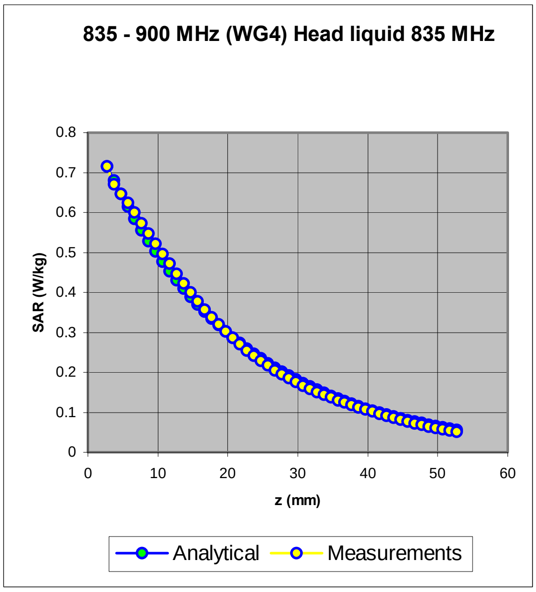
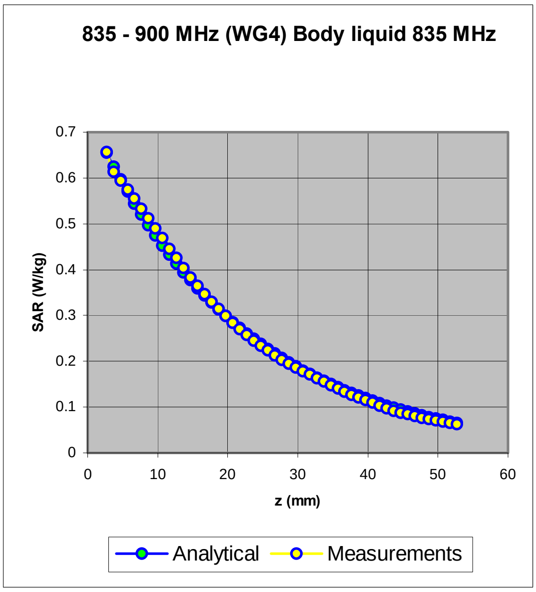
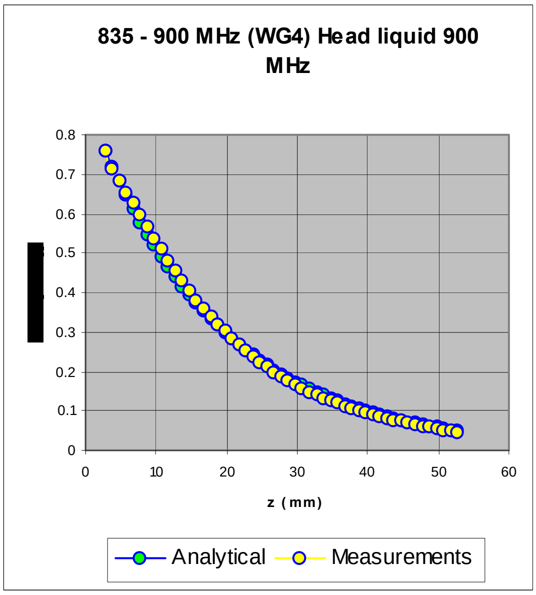


Figure 5. The rotational isotropy of probe S/N 0170 obtained by rotating the probe in a liquid-filled waveguide at 1800 MHz.

SAR DECAY FUNCTION – Analytical and Measurements







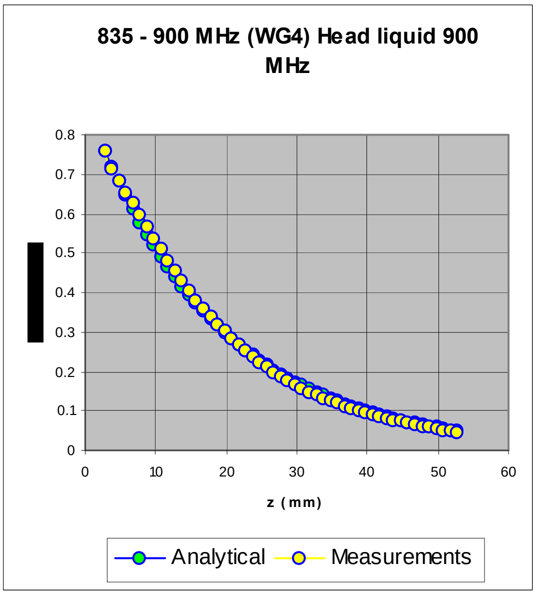


Figure 6a. The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical and Measurements

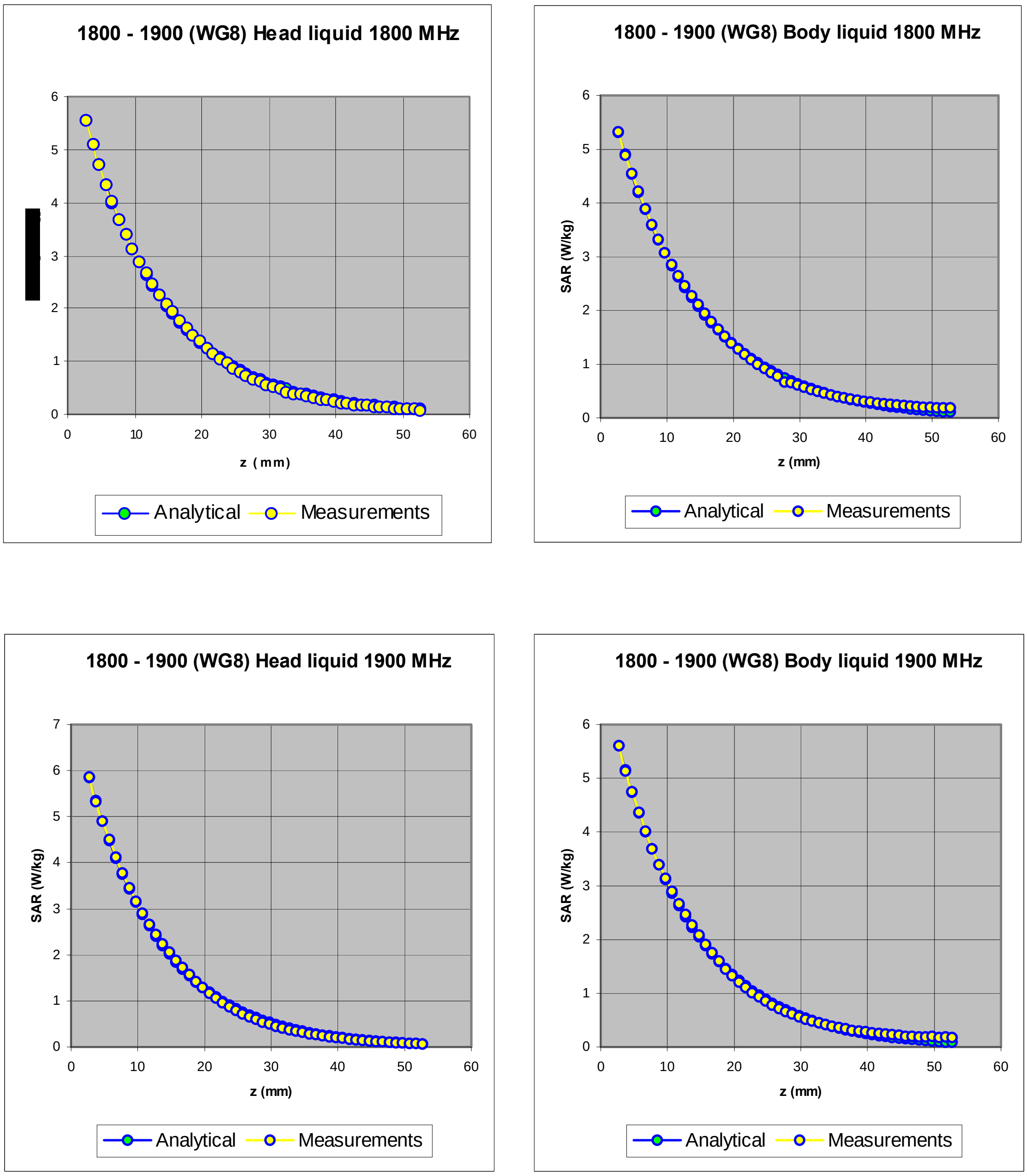


Figure 6b The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical and Measurements

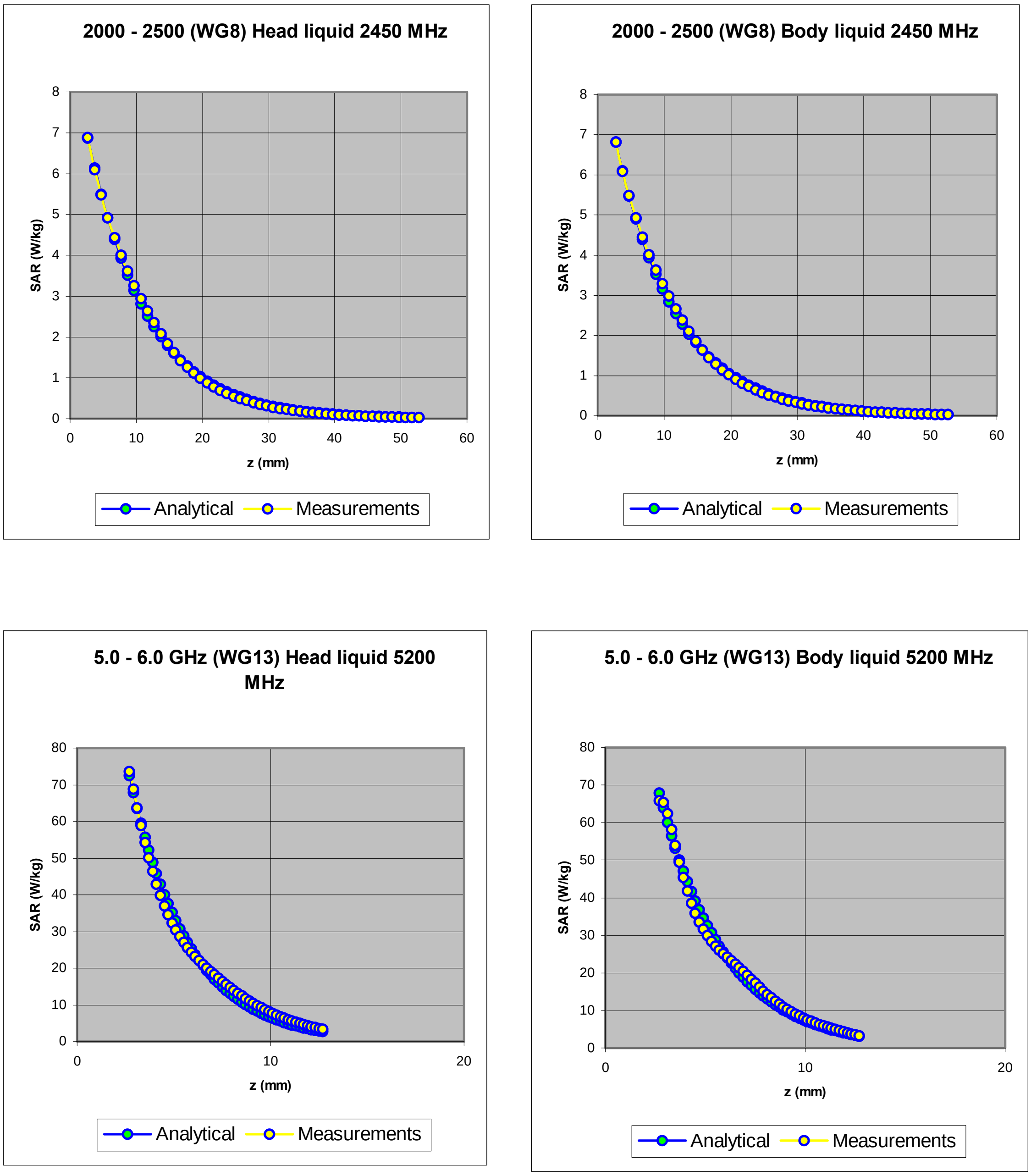
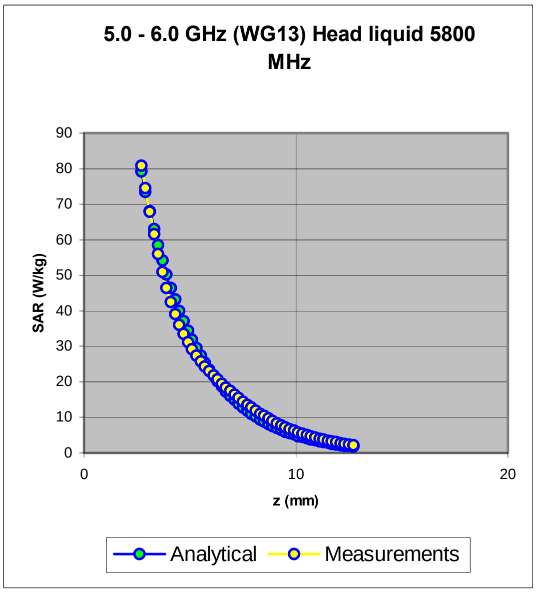


Figure 6c The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical and Measurements



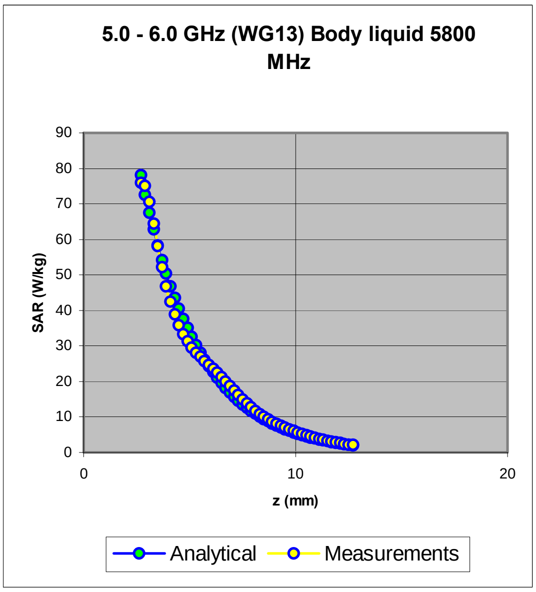


Figure 7. The measured SAR decay function along the centreline of the R22 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

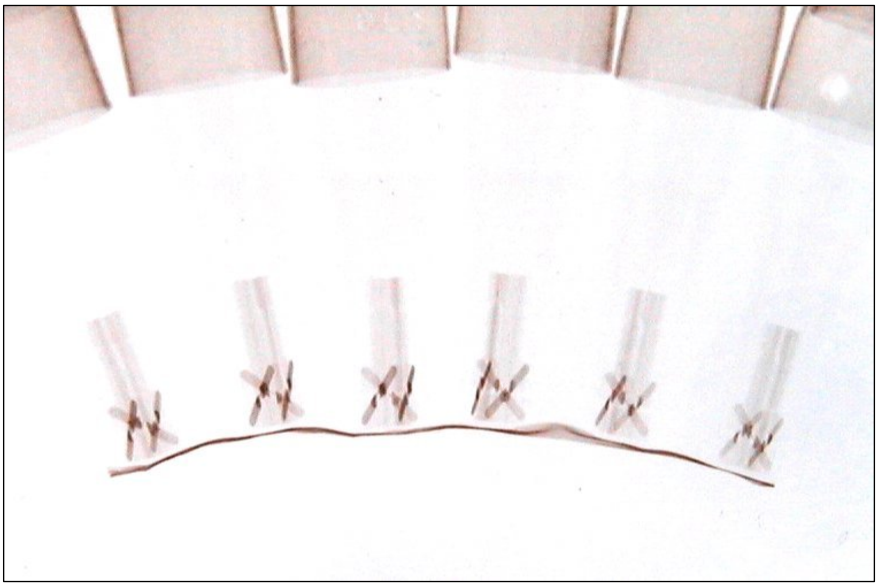


Figure 8: X-ray positive image of 5mm probes

TABLE INDICATING THE DIELECTRIC PARAMETERS OF THE LIQUIDS USED FOR CALIBRATIONS AT EACH FREQUENCY

Liquid used	Relative permittivity (measured)	Conductivity (S/m) (measured)
835 MHz BRAIN	41.07	0.89
835 MHz BODY	56.83	0.94
900 MHz BRAIN	40.28	0.95
900 MHz BODY	56.27	1.01
1800 MHz BRAIN	39.79	1.40
1800 MHz BODY	54.70	1.56
1900 MHz BRAIN	39.38	1.50
1900 MHz BODY	54.34	1.66
2450 MHz BRAIN	39.89	1.91
2450 MHz BODY	54.63	2.18
5200 MHz BRAIN	32.27	5.18
5200 MHz BODY	52.98	6.04
5800 MHz BRAIN	31.09	5.87
5800 MHz BODY	51.21	7.10