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SAR Evaluation on 490 MHz Handheld Transceiver Model: TOP-I2410-T0 FCC ID: CASTEL0015

For Tait Electronics Ltd to FCC OET Bulletin 65 – Supplement C (Edition 01-01)

Report Number: M030131

Issue Date: 12th March 2003

This report is not an endorsement of the subject product.
The results within apply to the test sample as tested.

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SAR EVALUATION
Tait Electronics Ltd Handheld Transceiver
Model: TOP-I2410-T0
Report Number: M030131
FCC ID: CASTEL0015

1.0 GENERAL INFORMATION

Test Sample:	Handheld Transceiver
Device Category:	Portable Transmitter
Test Device:	Production Unit
Model Number:	TOP-I2410-T0
FCC ID:	CASTEL0015
RF exposure Category:	Occupational/Controlled
Manufacturer:	Tait Electronics Ltd
Address:	558 Wairakei Road P.O. Box 1645 Christchurch 8005 New Zealand
Phone:	+64 3 358 3399
Fax:	+64 3 358 9299
Test Standard/s:	Evaluating Compliance with FCC Guidelines For Human Exposure to Radiofrequency Electromagnetic Fields Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01)
Statement Of Compliance:	The Tait Electronics Ltd Handheld Transceiver model TOP-I2410-T0 Complied with the FCC occupational/controlled RF exposure limits of 8.0mW/g per requirements of 47CFR2.1093(d).
Test Dates:	27th to 28th February and 1st March 2003
Tested for:	Tait Electronics Ltd
Address:	558 Wairakei Road P.O. Box 1645 Christchurch 8005 New Zealand
Phone:	+64 3 358 3399
Fax:	+64 3 358 9299
Contact:	Des Fox
Email:	des.fox@tait.co.nz

Test Officer:

Aaron Sargent
B.Eng

Authorised Signature:

Chris Zombolas
Technical Director, EMC Technologies Pty Ltd

SAR EVALUATION
Tait Electronics Ltd Handheld Transceiver
Model: TOP-I2410-T0
Report Number: M030131

2.0 DESCRIPTION OF DEVICE

2.1 Description of Test Sample

The device tested was a Tait Electronics Ltd Handheld Transceiver operating in the 490 MHz frequency band. It has three integral antennas tuned for the frequencies 450, 490 and 530 MHz. The test device was tested in the Touch, Tilted, Face Position and Belt-Clip configuration of the phantom.

Operating Mode during Testing	: Continuous Wave 100% duty cycle
Operating Mode production sample	: 20% duty cycle (1 minute Tx, 4 minutes Rx at maximum temperature and voltage)
Device Power Rating for test sample and identical production unit	: 4W for 7.5V battery
Antenna type	: Helical Rubber Antenna - 450MHz: Length 14.5cm - 490MHz: Length 13cm - 530MHz: Length 12cm
Applicable Head Configurations	: Touch and Tilted Position
Applicable Body Worn-Configurations	: Belt-Clip and Face Position
Battery Options	: TOPB400 1500mAH NiMH battery pack

2.2 Test sample Accessories

2.2.1 Battery Types

One type of battery is available with the Tait Electronics Ltd Handheld Transceiver. The battery used with the device is a 7.5V battery with the maximum rated power being 4W. SAR measurements were performed with the 7.5V battery model TOPB400.

2.2.2 Belt Clip

A *predominately plastic* belt clip is sold with the device. The belt clip is fixed to the back of the device and provides a spacing of 14mm between the device and flat phantom. This predominately plastic belt-clip was attached to the device during all testing.

2.2.3 External Hand Speaker/Microphone

A microphone with a cable length of approximately 46cm is an optional accessory. This accessory was connected to the device during testing in the belt-clip position. See photographs below.

2.3 Test Signal, Frequency and Output Power

The Handheld Transceiver had pre-programmed transmit channels corresponding to the low, middle and high frequencies of operation. This maintained a maximum output signal from the EUT in the frequency range 450 MHz to 530 MHz. The fixed frequency channels were used in testing and are shown in the table below. The SAR levels of the test sample were measured for the 490 MHz frequency band of operation. Excluding the Microphone accessory there were no wires or other connections to the Handheld Transceiver during the SAR measurements.

Table 1: Frequency and Output Power

Channel	Channel Frequency MHz	Maximum Conducted Output Power Measured
1	450.00	36.02
2	490.20	36.05
3	530.00	36.10

2.4 Battery Status

The device battery was fully charged prior to commencement of measurement. Each SAR test was completed within 30 minutes. The battery condition was monitored by measuring the RF field at a defined position inside the phantom before the commencement of each test and again after the completion of the test. The conducted power output at the antenna port of the device was also measured at the beginning and conclusion of each SAR measurement.

2.5 Modulation scheme

The Modulation scheme was Direct Frequency Modulation

2.6 Details of Test Laboratory

2.6.1 Location

EMC Technologies Pty Ltd - ACN/ABN: 82057105549
57 Assembly Drive
Tullamarine, (Melbourne) Victoria
Australia 3043

Telephone: +61 3 9335 3333
Facsimile: +61 3 9338 9260
email: melb@emctech.com.au
website: www.emctech.com.au

2.6.2 Accreditations

EMC Technologies Pty. Ltd. is accredited by the National Association of Testing Authorities, Australia (NATA). **NATA Accredited Laboratory Number: 5292**

EMC Technologies Pty Ltd is NATA accredited for the following standards:

AS/NZS 2772.1:	RF and microwave radiation hazard measurement
ACA:	Electromagnetic Radiation Human Exposure Standard
FCC:	Guidelines for Human Exposure to RF Electromagnetic Field
CENELEC:	ES59005

Refer to NATA website www.nata.asn.au for the full scope of accreditation.

2.6.3 Environmental Factors

The measurements were performed in a shielded room with no background network signals. The temperature in the laboratory was controlled to within 21±1 °C, the humidity was in the range 50% to 65%. The liquid parameters were measured daily prior to the commencement of each test. Tests were performed to check that reflections within the environment did not influence the SAR measurements. The noise floor of the DASY4 SAR measurement system using the SN1377 probe is less than 5μV in both air and liquid mediums.

3.0 DESCRIPTION OF SAR MEASUREMENT SYSTEM

3.1 Probe Positioning System

The measurements were performed with the state of the art automated near-field scanning system **DASY4 V4.0 Build51** from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision 6-axis robot (working range greater that 1.1m), which positions the SAR measurement probes with a positional repeatability of better than ±0.02 mm. The DASY4 fully complies with the OET65 C (01-01), IEEE 1528 and EN50361SAR measurement requirements.

3.2 E-Field Probe Type and Performance

The SAR measurements were conducted with the dosimetric probe ET3DV6 Serial: 1377 (manufactured by SPEAG) designed in the classical triangular configuration and optimised for dosimetric evaluation. The probe has been calibrated and found to be accurate to better than ±0.25 dB. The probe is suitable for measurements close to material discontinuity at the surface of the phantom. The sensors of the probe are directly loaded with Schottky diodes and connected via highly resistive lines (length = 300 mm) to the data acquisition unit.

3.3 Data Acquisition Electronics

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. The input impedance of the DAE3 box is 200 MΩ; the inputs are symmetrical and floating. Common mode rejection is above 80dB.Transmission to the PC-card is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The mechanical probe-mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

3.4 Calibration and Validation Procedures and Data

Prior to the SAR assessment, the system validation kit was used to verify that the DASY4 was operating within its specifications. The validation was performed at 450 MHz with the SPEAG D450V2 calibrated dipole.

The validation dipoles are highly symmetric and matched at the centre frequency for the specified liquid and distance to the phantom. The accurate distance between the liquid surface and the dipole centre is achieved with a distance holder that snaps onto the dipole.

System validation is performed by feeding a known power level into a reference dipole, set at a know distance from the phantom. The measured SAR is compared to the theoretically derived level.

3.4.1 Validation Results @ 450MHz

Validation Date 27-Feb-03 Dipole: SPEAG D450V2 SN: 1009

Frequency	∈r (measured)	σ (mho/m) (measured)	Power Into Antenna	Measured SAR 1g	Measured SAR 10g
450MHz	43.92	0.90	250mW	1.27mW/g	0.817mW/g

Validation Date 28-Feb-03 Dipole: SPEAG D450V2 SN: 1009

Frequency	∈r (measured)	σ (mho/m) (measured)	Power Into Antenna	Measured SAR 1g	Measured SAR 10g
450MHz	43.25	0.89	250mW	1.28mW/g	0.822mW/g

Validation Date 01-Mar-03 Dipole: SPEAG D450V2 SN: 1009

Frequency	∈r (measured)	σ (mho/m) (measured)	Power Into Antenna	Measured SAR 1g	Measured SAR 10g
450MHz	55.99	0.93	250mW	1.19mW/g	0.779mW/g

3.4.2 Deviation from reference validation values

Frequency	Measured SAR 1g	Measured SAR 1g (Normalized to 1W)	SPEAG Calibration reference SAR Value (1g)	Deviation From SPEAG (1g)	IEEE Std 1528 reference SAR value (1g)	Deviation From IEEE (1g)
450MHz 27-Feb-03	1.27mW/g	5.08mW/g	4.97mW/g	2.2%	4.90mW/g	3.7%
450MHz 28-Feb-03	1.28mW/g	5.12mW/g	4.97mW/g	3.0%	4.90mW/g	4.5%
450MHz 01-Mar-03	1.19mW/g	4.76mW/g	4.97mW/g	-4.2%	4.90mW/g	-2.9%

NOTE: All reference validation values are referenced to 1W input power.
NOTE: The measured one-gram SAR should be within 10% of the expected target reference values shown above.

3.4.3 Liquid Depth 15cm

During the SAR measurement process the liquid level was maintained to 15cm with a tolerance of ±0.2cm. The following photo shows the depth of the liquid maintained during the testing.

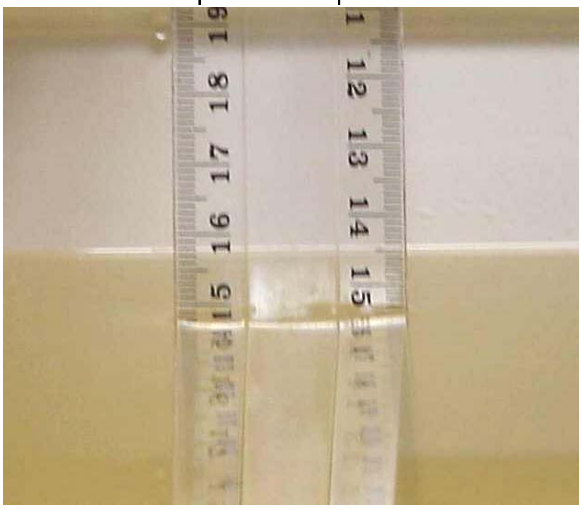


Photo of liquid Depth in Flat Phantom

3.5 Phantom Properties (Size, Shape, Shell Thickness, Tissue Material Properties)

The phantom used was the "Flat Phantom V4.4" from SPEAG. It is a combination 6mm/2mm Flat Phantom and was filled with the tissue simulating liquid. The flat phantom support structures were all non-metallic and spaced more than one device width away in transverse directions. The phantom thickness under the DUT was 2.0mm+/-0.2 mm.

The dielectric parameters of the brain simulating liquid were measured prior to SAR assessment using the HP85070A dielectric probe kit and HP8714B Network Analyser. The actual dielectric parameters are shown in the following table.

Table 2: Measured Brain Simulating Liquid Dielectric Values

Frequency Band	∈r (measured)	∈r (target)	σ (mho/m) (measured)	σ (target)	ρ kg/m^3
450 MHz Brain	44.02	43.5 ±5% (41.3 to 45.6)	0.86	0.87 ±5% (0.83 to 0.91)	1000

Table 3: Measured Body Simulating Liquid Dielectric Values

Frequency Band	∈r (measured)	∈r (target)	σ (mho/m) (measured)	σ (target)	ρ kg/m^3
450 MHz Muscle	56.0	56.7 ±5% (53.9 to 59.5)	0.93	0.94 ±5% (0.89 to 0.98)	1000

The brain and muscle liquid parameters were within the required tolerances of ±5%.

3.5.1 Liquid Temperature and Humidity

Measurement	Date: 27-Feb-03	Date: 28-Feb-03	Date: 01-Mar-03
Ambient Temperature	20.7	22.2	21.4
Liquid Temperature	20.1	20.2	20.4
Humidity	65%	59%	44%

3.6 Simulated Tissue Composition Used for SAR Test

Tissue Type: Brain @ 450MHz
Volume of Liquid: 60 Litres

Approximate Composition	% By Weight
Distilled Water	38.56
Salt	3.95
Sugar	56.32
HEC	0.98
Bactericide	0.19

Tissue Type: Muscle @ 450MHz
Volume of Liquid: 60 Litres

Approximate Composition	% By Weight
Distilled Water	51.16
Salt	1.49
Sugar	46.78
HEC	0.52
Bactericide	0.05

*Refer "OET Bulletin 65 97/01 P38"

3.7 Device Holder for DASY4

The DASY4 device holder supplied by SPEAG is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The rotation centres for both scales is the ear opening. Thus the device needs no repositioning when changing the angles.

The DASY4 device holder is made of low-loss material having the following dielectric parameters: relative permittivity ε=3 and loss tangent δ=0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, to reduce the influence on the clamp on the test results.

A foam spacer is used to raise the device above the clamp of the device holder to minimise any affect on the radiation characteristics of the device. In cases where foam is not used the device is mounted so that the antenna is unobstructed.

Refer to Appendix A2 for photograph of device positioning.

4.0 SAR MEASUREMENT PROCEDURE USING DASY4

The SAR evaluation was performed with the SPEAG DASY4 system. A summary of the procedure follows:

a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the phone. The SAR at this point is measured at the start of the test and then again at the end of the test.

b) The SAR distribution at the exposed side of the head or the flat section of the flat phantom is measured at a distance of 3.9 mm from the inner surface of the shell. The area covers the entire dimension of the head and the horizontal grid spacing is 20 mm x 20 mm. The actual Area Scan has dimensions of 150mm x 300mm surrounding the test device. Based on this data, the area of the maximum absorption is determined by Spline interpolation.

c) Around this point, a volume of 30 mm x 30 mm x 30 mm is assessed by measuring 7 x 7 x 7 points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:

  (i) The data at the surface are extrapolated, since the centre of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.

  (ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot”- condition (in x, y and z-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.

  (iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

  (iv) The SAR value at the same location as in Step (a) is again measured

5.0 MEASUREMENT UNCERTAINTY

Table 4: Uncertainty Budget for DASY4 Version V4.0 Build 51

a	b	c	d	e= f(d,k)	f	g	h=cxf/e	i=cxg/e	k
Uncertainty Component	Sec.	Tol. (± %)	Prob. Dist.	Div.	C_i (1g)	C_i (10g)	1g u_i (± %)	10g u_i (± %)	v_i
Measurement System									
Probe Calibration (k=1) (numerical calibration)	E.2.1	8	N	1	1	1	8	8	∞
Axial Isotropy	E.2.2	4.7	R	√3	0.707	0.707	1.9	1.9	∞
Hemispherical Isotropy	E.2.2	9.6	R	√3	0.707	0.707	3.9	3.9	∞
Boundary Effect	E.2.3	0.4	R	√3	1	1	0.23	0.23	∞
Linearity	E.2.4	4.7	R	√3	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	√3	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	1.0	N	1	1	1	1.0	1.0	∞
Response Time	E.2.7	0.8	R	√3	1	1	0.5	0.5	∞
Integration Time	E.2.8	1.4	R	√3	1	1	0.8	0.8	∞
RF Ambient Conditions	E.6.1	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	1.4	R	√3	1	1	0.81	0.81	∞
Probe Positioning with respect to Phantom Shell	E.6.3	2.9	R	√3	1	1	1.7	1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E.5	3.6	R	√3	1	1	2.1	2.1	∞
Test Sample Related									
Test Sample Positioning	E.4.2	6	N	1	1	1	6.0	6.0	11
Device Holder Uncertainty	E.4.1	3.1	N	1	1	1	3.1	3.1	7
Output Power Variation – SAR Drift Measurement	6.6.2	6	R	√3	1	1	3.5	3.5	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4.0	R	√3	1	1	2.3	2.3	∞
Liquid Conductivity – Deviation from target values	E.3.2	5.0	R	√3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity – Measurement uncertainty	E.3.3	10	N	1	0.64	0.43	6.4	4.3	5
Liquid Permittivity – Deviation from target values	E.3.2	5.0	R	√3	0.6	0.49	1.7	2.8	∞
Liquid Permittivity – Measurement uncertainty	E.3.3	2.9	N	1	0.6	0.49	1.7	1.5	5
Combined standard Uncertainty			RSS				14.7	14	154
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				±29.4	±28.0	

Estimated total measurement uncertainty for the DASY4 measurement system was ±14.7%. The extended uncertainty (K = 2) was assessed to be ±29.4% based on 95% confidence level. The uncertainty is not added to the measurement result.

6.0 EQUIPMENT LIST AND CALIBRATION DETAILS

Table 5 SPEAG DASY4 Version 4.0 Build 51

Equipment Type	Manufacturer	Model Number	Serial Number	Calibration Due
Robot - Six Axes	Staubli	RX90BL	N/A	Not applicable
Robot Remote Control	Schmid & Partner Engineering AG	CS7MB	RX90B	Not applicable
SAM Phantom	Schmid & Partner Engineering AG	N/A	1060	Not applicable
Flat Phantom	Schmid & Partner Engineering AG	V4.4 Combination 6.00/2.00mm	1001	Not Applicable
Flat Phantom	Schmid & Partner Engineering AG	PO1A V4.4e 6mm	1003	Not Applicable
Data Acquisition Electronics	Schmid & Partner Engineering AG	DAE3 V1	442	Oct – 03
Probe E-Field - Dummy	Schmid & Partner Engineering AG	DP1	N/A	Not applicable
Probe E-Field	Schmid & Partner Engineering AG	ET3DV6	1377	6–Sept-03
Antenna Dipole 450 MHz	Schmid & Partner Engineering AG	D450V2	1009	24-Jan-05
RF Amplifier	Mini-Circuits	ZHL-42	N/A	Not applicable
Synthesized signal generator	Hewlett Packard	ESG-D3000A	GB37420238	In test
RF Power Meter Dual	Hewlett Packard	437B	3125012786	23-May-03
RF Power Sensor 0.01 - 18 GHz	Hewlett Packard	8481H	1545A01634	23-May-03
RF Power Meter Dual	Gigatronics	8542B	1830125	10-Sept-03
RF Power Sensor	Gigatronics	80301A	1828805	10-Sept-03
Network Analyser	Hewlett Packard	8714B	GB3510035	10-Sept-03
Dual Directional Coupler	NARDA	3022	75453	In test
Spectrum Analyser 9 kHz - 22 GHz	Hewlett Packard	8593EM	3412A00105	23-May-03

7.0 OET BULLETIN 65 – SUPPLEMENT C TEST METHOD

7.1 Description of the Test Positions (Belt Clip and In front of face)

SAR measurements were performed in the “Face Position” and “Belt Clip” positions. Both the “Belt Clip” and “Face position” were measured in the flat section of the phantom.
See Appendix A for photos of test positions.

7.1.1 “Belt Clip” Position

The device was tested in the 2.00mm section of the flat phantom for the “Belt Clip” position. A belt clip maintained a distance of approximately 14mm between the back of the device and the flat phantom. The Transceiver was placed at the flat section of the phantom and suspended until the Belt Clip touched the phantom. The belt clip was made predominately of plastic. The device was connected with the speaker microphone; the microphone and cable were taped to the phantom. This was equivalent to the device worn at the belt position with the speaker microphone at the shoulder.

7.1.2 "Face Position"

The SAR evaluation was performed in the 2.00mm section of the flat phantom. The device was placed 25mm from the phantom, this position is equivalent to the device placed in front of the nose. The supporting hand was not used.

SAR measurements were performed in the "Touch" and "Tilted" positions. The SAR evaluations were performed on both left and right hand side of both the "Touch Position" and the "Tilted Position".

7.1.3 *"Touch Position"*

The devices was positioned with the vertical centre line of the body of the device and the horizontal line crossing the centre of the ear piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, the vertical centre line was aligned with the reference plane containing the three ear and mouth reference points. (Left Ear, Right Ear and Mouth). The centre of the earpiece was then aligned with the Right Ear and Left Ear.

The phone was then moved towards the phantom with the earpiece aligned with the line between the Left Ear and the Right Ear, until the phone just touched the ear. With the device maintained in the reference plane, and the phone in contact with the ear, the bottom of the phone was moved until the front side of the phone was in contact with the cheek of the phantom, or until contact with the ear was lost.

7.1.4 *"Tilted Position"*

The device was positioned in the "Touch" position described above. While maintaining the device in the reference plane describe above, and pivoting against the ear, the device was moved away from the mouth by an angle of 15 degrees or until contact with the ear was lost

7.2 List of All Test Cases (Antenna In/Out, Test Frequencies, User Modes)

The device has a fixed antenna. The SAR was measured at three test channels with the test sample operating at maximum power, as specified in section 2.3.

7.3 FCC RF Exposure Limits for Occupational/ Controlled Exposure

Spatial Peak SAR Limits For:	
Partial-Body:	8.0 mW/g (averaged over any 1g cube of tissue)
Hands, Wrists, Feet and Ankles:	20.0 mW/g (averaged over 10g cube of tissue)

7.4 FCC RF Exposure Limits for Un-controlled/Non–occupational

Spatial Peak SAR Limits For:	
Partial-Body:	1.6 mW/g (averaged over any 1g cube of tissue)
Hands, Wrists, Feet and Ankles:	4.0 mW/g (averaged over 10g cube of tissue)

8.0 SAR EVALUATION RESULTS

The SAR values averaged over 1 g and 10 g tissue masses were determined for the sample device for the Face Position and belt-clip configurations of the phantom. The results are given in Table 6 (Head Positions) and Table 7 (Body Worn and Face Positions), 450 to 530MHz (490 MHz band). The SAR plots are contained in Appendix B of this report

.

Table 6: SAR Measurement Results – Head Positions - 460 MHz Band (450 to 530MHz)

Test Position	Plot No.	Test Channel	**Test Freq (MHz)**	**SAR Level for (1g)**	**DASY4 Measured Drift (dB) From SAR Plot**	**Conducted Power Measured Before Test (dBm) (*1)**	**Conducted Power Measured After Test (dBm) (*2)**	**Conducted Power Measured Drift (dB)**	**Conducted Power Measured Droop (dB) from values in Table 1 (*3)**
Touch Left	1	1	450	*4.08*	0.2	33.20	33.44	0.24	-2.58
Touch Left	2	2	490	*6.12*	-0.55	35.50	34.95	-0.55	-1.1
Touch Left	**3**	**3**	**530**	***10.1***	**-0.7**	**35.90**	**35.88**	**-0.02**	-0.22
Touch Left with DC Power Supply	4	4	530	*6.46*	0.00	35.41	35.39	-0.02	-0.71
Touch Right	5	1	450	*2.87*	-1.0	32.96	31.97	-0.99	-4.05
Touch Right	6	2	490	*6.01*	-2.0	35.18	34.56	-0.62	-1.49
Touch Right	7	3	530	*10.0*	-0.5	35.75	35.22	-0.53	-0.88
Touch Right with DC Power Supply	8	3	530	*6.91*	0.03	35.30	35.45	0.15	-0.65
Tilted Left	9	1	450	*3.15*	-1.0	32.82	31.75	-1.07	-4.27
Tilted Left	10	2	490	*8.14*	-0.80	35.63	34.81	-0.82	-1.24
Tilted Left	11	3	530	*9.61*	-0.80	35.82	35.04	-0.78	-1.06
Tilted Left with DC Power Supply	12	3	530	*7.66*	-0.1	35.45	35.28	-0.17	-0.82
Tilted Right	13	1	450	*3.24*	-1.0	32.85	31.53	-1.32	-4.49
Tilted Right	14	2	490	*9.50*	-0.9	35.48	34.52	-0.96	-1.53
Tilted Right	**15**	**3**	**530**	***10.3***	**-0.6**	**35.56**	**35.00**	**-0.56**	-1.1
Tilted Right with DC Power Supply	16	3	530	*10.2*	-0.06	35.39	35.30	-0.09	-0.8

Note *1: The power in dBm measured immediately prior to commencement of SAR scanning and after the 20 minute battery discharge time.
Note*2: The power in dBm measured immediately after the conclusion of the SAR scan. (approximately 28 minutes after the 20-minute warm-up.
Note *3: The difference in dB between initial power at switch-on (table 1) and the conducted power measured after conclusion of SAR test.

Table 7: SAR Measurement Results – Body Worn and Face Positions – 490 MHz Band (450 to 530MHz)

Test Position	Plot No.	Test Channel	**Test Freq (MHz)**	**SAR Level for (1g)**	**DASY4 Measured Drift (dB) From SAR Plot**	**Conducted Power Measured Before Test (dBm) (*1)**	**Conducted Power Measured After Test (dBm) (*2)**	**Conducted Power Measured Drift (dB)**	**Conducted Power Measured Droop (dB) from values in Table 1 (*3)**
Face Position	15	1	450	*2.35*	-1.0	34.36	33.64	-0.72	-2.38
Face Position	16	2	490	*2.81*	0.1	35.05	34.46	-0.59	-1.59
Face Position	**17**	**3**	**530**	***4.66***	**-0.3**	**35.82**	**35.46**	**-0.36**	-0.64
Face Position with DC Power supply	18	3	530	*3.48*	-0.4	35.99	35.96	-0.03	-0.14
Belt Clip Position	19	1	450	3.57	-3.0	33.25	33.30	0.05	-2.72
Belt Clip Position	20	2	490	4.01	-0.3	34.91	34.51	-0.40	-1.54
Belt Clip Position	**21**	**3**	**530**	**5.76**	**-1.0**	**36.01**	**35.02**	**-0.99**	-1.08
Belt Clip Position with DC Power Supply	22	3	530	6.49	-0.3	35.19	35.00	-0.19	-1.10

Note *1: The power in dBm measured immediately prior to commencement of SAR scanning and after the 20 minute battery discharge time.
Note*2: The power in dBm measured immediately after the conclusion of the SAR scan. (approximately 28 minutes after the 20-minute warm-up.
Note *3: The difference in dB between initial power at switch-on (table 1) and the conducted power measured after conclusion of SAR test.

9.0 FINAL SAR EVALUATION

The SAR values averaged over 1 g and 10 g tissue masses were determined for the sample device for Head, Face and Belt-Clip configurations of the phantom.

9.1 Power Droop Considerations

Because of the power droop of this device, some additional tests were undertaken to ensure that the measured SAR levels were conservative. This testing used an external DC power supply to supplement the battery (7.5V) while shielded cables and ferrites were used on all wires connecting to the device.

For all measurements using the 7.5V battery, the conducted power measured at the end of the scan was used to scale up the measured SAR value to account for the power droop. This method provides a more conservative assessment of the SAR. The test sample used a fresh battery at the beginning of each SAR scan. The power drainage of the device has been recorded for the first 30 minutes of the scan and a typical "power vs. time" plot can be found in Appendix C. The approximate time to complete a full SAR scan was 28 minutes.
Refer to Appendix A for photos of test setup.

All SAR scans were performed after the device was transmitting at full power for 20mins and then the resulting SAR was scaled up to full power per the list in the report Table 1.

9.2 Definition of Power Droop

The reference-conducted power for each channel was taken as the initial power measured at the time of "power on". The conducted power measured at the conclusion of each SAR scan was taken as the final power and is shown in Tables 6 and 7. The difference between the two power measurements was the power droop. The measured SAR was scaled up to account for the droop so giving a worst-case estimate of the SAR at the point of first powering up the DUT.

Table 8: Final Extrapolated SAR Results and Additional Tests

Test Position	Plot No.	Test Channel	Test Freq (MHz)	SAR Level for (1g) Measured	Measured SAR (1g) scaled up for droop.	Scaled up SAR for droop & Extrapolated 50% duty Cycle	Scaled up SAR for droop & Extrapolated 20% duty Cycle	20% Duty cycle and Including the measurement uncertainty of 29.4%
Touch Left	1	1	450	*4.08*	7.38	3.69	1.48	1.91
Touch Left	2	2	490	*6.12*	7.83	3.92	1.57	2.03
Touch Left	3	3	**530**	***10.1***	10.63	5.31	2.13	2.75
Touch Left with DC Power Supply	3	3	530	*6.46*	7.62	3.81	1.52	1.97
Touch Right	4	1	450	*2.87*	7.29	3.64	1.46	1.89
Touch Right	5	2	490	*6.01*	8.47	4.24	1.69	2.19
Touch Right	6	3	530	*10.0*	12.20	6.10	2.44	3.16
Touch Right with DC Power Supply	7	3	530	*6.91*	8.02	4.01	1.60	2.07
Tilted Left	8	1	450	*3.15*	8.41	4.21	1.68	2.18
Tilted Left	9	2	490	*8.14*	10.83	5.41	2.17	2.80
Tilted Left	10	3	530	*9.61*	12.30	6.15	2.46	3.18
Tilted Left with DC Power Supply	3	3	530	*7.66*	9.27	4.63	1.85	2.40
Tilted Right	11	1	450	*3.24*	9.10	4.55	1.82	2.36
Tilted Right	12	2	490	*9.50*	13.49	6.75	2.70	3.49
Tilted Right	13	3	530	***10.3***	13.29	6.64	2.66	3.44
Tilted Right with DC Power Supply	14	3	530	*10.2*	12.24	6.12	2.45	3.17
Face Position	15	1	450	*2.35*	4.07	2.03	0.81	1.05
Face Position	16	2	490	*2.81*	4.05	2.02	0.81	1.05
Face Position	17	3	**530**	***4.66***	5.41	2.70	1.08	1.40
Face Position with DC Power supply	18	3	530	*3.48*	3.58	1.79	0.72	0.93
Belt Clip Position	19	1	450	3.57	6.68	3.34	1.34	1.73
Belt Clip Position	20	2	490	4.01	5.73	2.87	1.15	1.48
Belt Clip Position	21	3	**530**	**5.76**	7.37	3.69	1.47	1.91
Belt Clip Position with DC Power Supply	22	3	530	6.49	8.37	4.19	1.67	2.17

9.3 Summary of Final SAR Evaluation

The test limit set by the FCC is 8.0 mW/g for a 1g cube of tissue for the head and body worn positions

9.3.1 Touch Position

The maximum measured SAR level at the Touch position for 100% duty cycle, without DC supplemented batteries was 10.1 mW/g for a 1-gram cube of tissue measured with channel 3 at the left side of the head. When the SAR is scaled up by the droop and extrapolated for a 20% duty cycle the maximum SAR level is 2.44 mW/g for a 1g-cube on tissue at the Right side of the head and using channel 3.

The maximum measured SAR level at the Touch position for 100% duty cycle, with DC power supply supplemented batteries, was 6.91 mW/g for a 1-gram cube of tissue measured with channel 3 at the right side of the head. When the SAR is scaled up by the measured droop and extrapolated for a 20% duty cycle the maximum SAR level is 1.60 mW/g for a 1g-cube on tissue at the Right side of the head and using channel 3.

9.3.2 Tilted Position

The maximum measured SAR level at the Tilted position with 100% duty cycle, without DC supplemented batteries was 10.3 mW/g for a 1-gram cube of tissue measured with channel 3 at the right side of the head. When the SAR is scaled up by the measured droop and extrapolated for a 20% duty cycle the maximum SAR level is 2.66 mW/g for a 1g-cube on tissue at the Right side of the head and using channel 3.

The maximum measured SAR level at the Tilted position with 100% duty cycle, with a DC power supply supplementing the batteries was 10.2 mW/g for a 1-gram cube of tissue measured with channel 3 at the Right side of the head. When the SAR is scaled up by the measured droop and extrapolated for a 20% duty cycle the maximum SAR level is 2.45 mW/g for a 1g-cube on tissue at the Right side of the head and using channel 3.

9.3.3 Face Position

The maximum measured SAR level at the Face position with 100% duty cycle, without DC supplemented batteries was 4.66 mW/g for a 1-gram cube of tissue measured for channel 3. When the SAR is scaled up by the measured droop and extrapolated for a 20% duty cycle the SAR level is 1.08 mW/g for a 1g-cube of tissue.

The maximum measured SAR level at the Face position with 100% duty cycle, using a DC supply to supplement the batteries was 3.48 mW/g for a 1-gram cube of tissue measured with channel 3. When the SAR is scaled up by the measured drift and extrapolated for a 20% duty cycle the SAR level is 0.72 mW/g for a 1g-cube of tissue.

9.3.4 Belt-Clip Position

The maximum measured SAR level at the Belt-Clip position with 100% duty cycle, without DC supplemented batteries was 5.76 mW/g for a 1-gram cube of tissue measured with channel 3. When the SAR is scaled up by the measured droop and extrapolated for a 20% duty cycle the SAR level is 1.47 mW/g for a 1g-cube of tissue.

The maximum measured SAR level at the Belt-Clip position using the DC supplemented batteries was 6.49 mW/g for a 1-gram cube of tissue when measured with channel 3. When the SAR is scaled up by the measured droop and extrapolated for a 20% duty cycle the SAR level is 1.67 mW/g for a 1g- cube of tissue.

10.0 COMPLIANCE STATEMENT

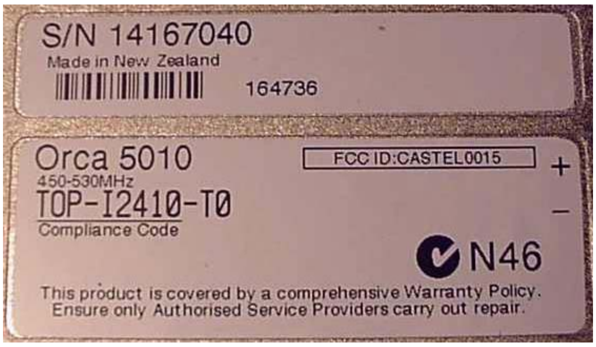
The Tait Electronics Ltd Model TOP-I2410-T0 FCC ID: CASTEL0015 490 MHz Handheld Transceiver was found to comply with the FCC SAR requirements.

After extrapolating to a 20% duty cycle and scaling the SAR values by the measured droop the highest SAR level recorded was 2.70 mW/g for a 1g cube. This value was measured on channel 2 in the "Tilted Right" position without a DC power supply supplementing the 7.5V battery. This was below the limit of 8.0 mW/g, even taking the measurement uncertainty into account.

APPENDIX A1
TEST SAMPLE PHOTOGRAPHS

Tait Electronics Ltd
Model: TOP-I2410-T0

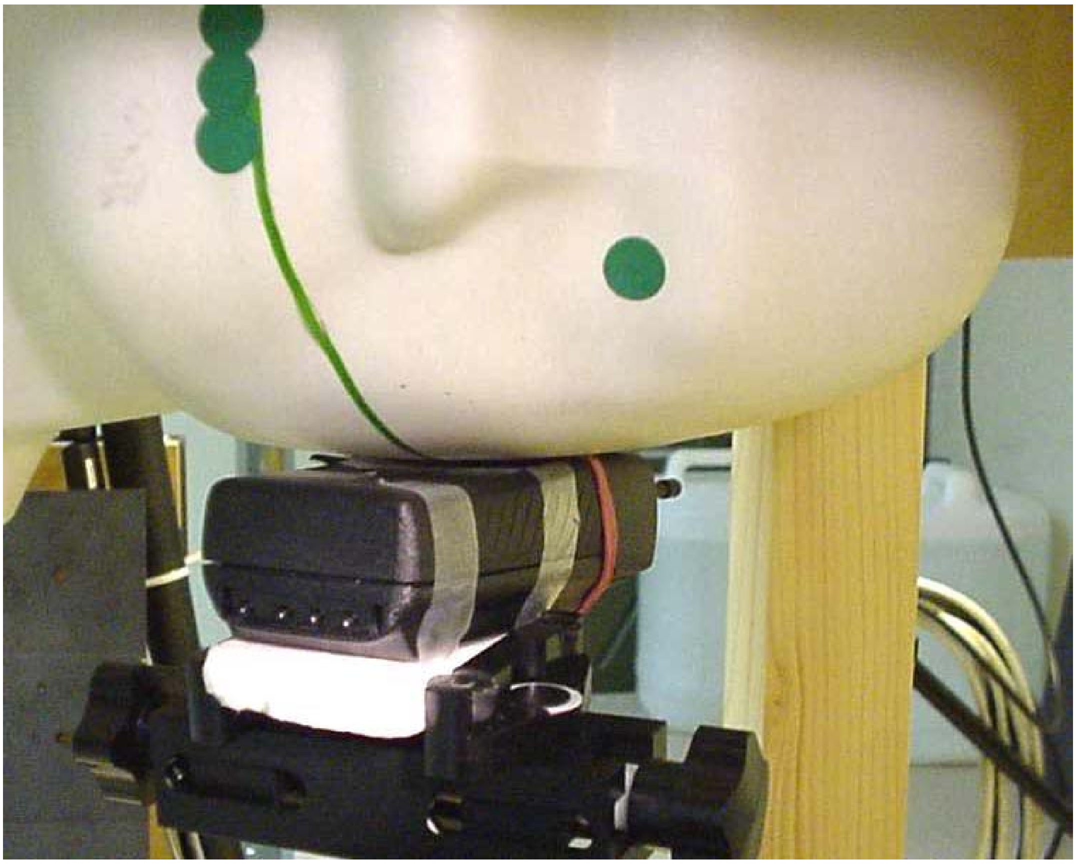
Device Serial Number



Antennas

APPENDIX A2
TEST SETUP PHOTOGRAPHS

Touch Left Position

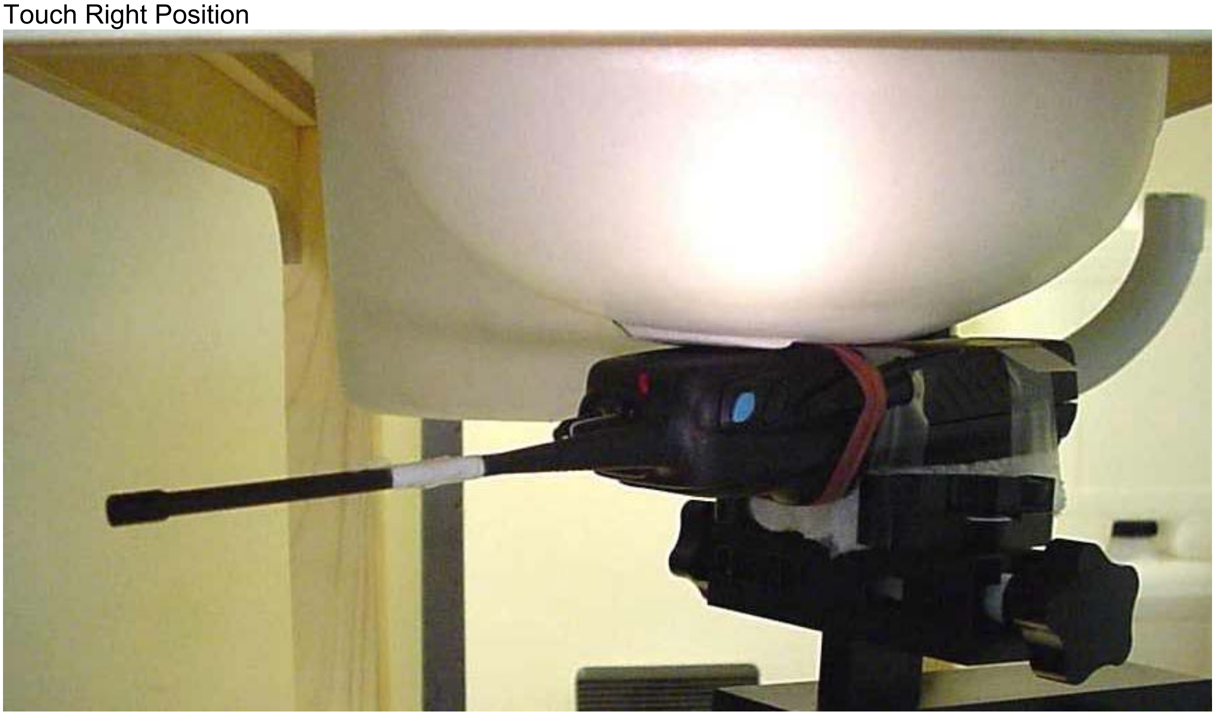


Touch Left Position

APPENDIX A3
TEST SETUP PHOTOGRAPHS

Touch Right Position

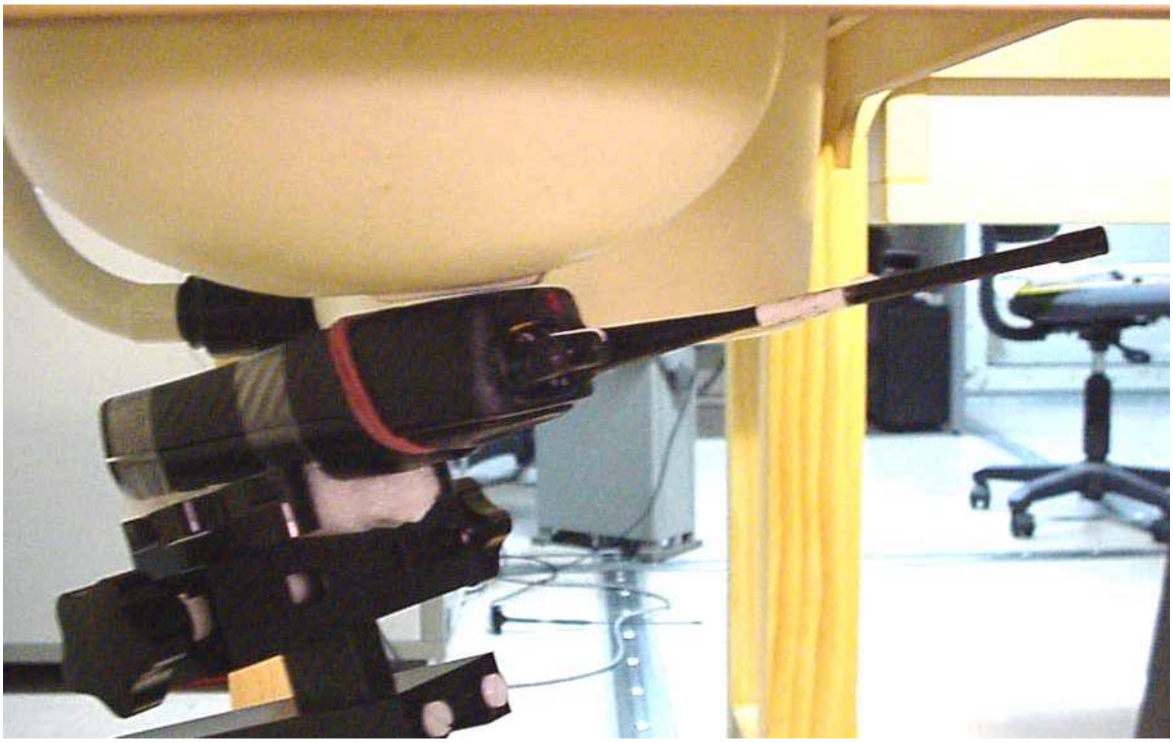
Touch Right Position



APPENDIX A4
TEST SETUP PHOTOGRAPHS

Tilted Left Position

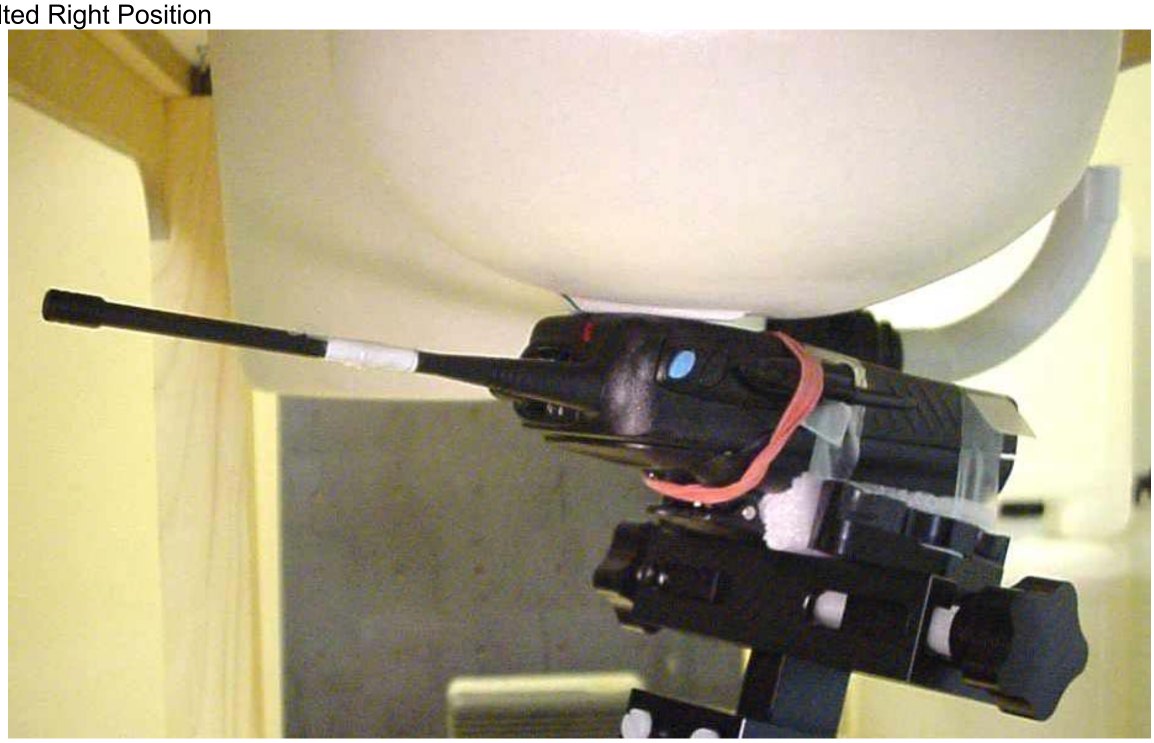
Tilted Left Position



APPENDIX A5
TEST SETUP PHOTOGRAPHS

Tilted Right Position

Tilted Right Position



APPENDIX A6
TEST SETUP PHOTOGRAPHS

Face Position

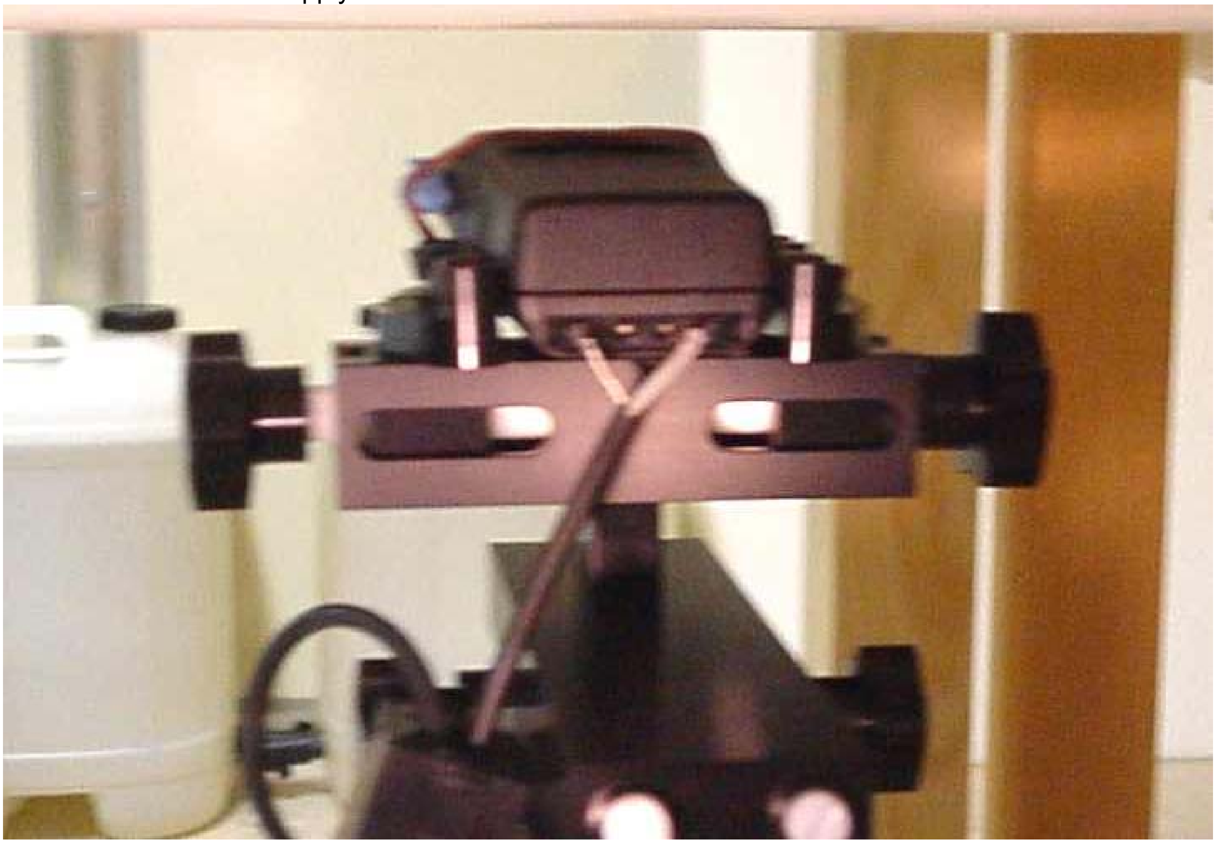
NOTE: Wooden spacer removed during testing

Face Position

NOTE: Wooden spacer removed during testing

APPENDIX A7
TEST SET UP PHOTOGRAPHS

Face Position with DC supply connected



NOTE: Wooden spacer removed during testing

Face Position with DC supply connected

NOTE: Wooden spacer removed during testing

APPENDIX A8
TEST SET UP PHOTOGRAPHS

Belt Clip Position

Belt Clip Position

APPENDIX A9
TEST SET UP PHOTOGRAPHS

Belt Clip Position with DC power supply

Belt Clip Position with DC power supply

APPENDIX B
PLOTS OF THE SAR MEASUREMENTS

Plots of the measured SAR distributions inside the phantom are given in this Appendix for all tested configurations. The spatial peak SAR values were assessed with the procedure described in this report.

Note: The graphical visualisation of the phone position onto the plot of the SAR distribution gives only limited information on the RF current distribution on the surface of the device, since the curvature of the head causes graphical distortion.

Tables 6, 7 and 8 contain a numbered list of the SAR plots.

490 MHz Band SAR Measurement Plot Numbers

Plot 1	Touch Left Z-Axis Scan	Channel 1 Channel 1
Plot 2	Touch Left Z-Axis Scan	Channel 2 Channel 2
Plot 3	Touch Left Z-Axis Scan	Channel 3 Channel 3
Plot 4	Touch Left with DC Power Supply Z-Axis Scan	Channel 3 Channel 3
Plot 5	Touch Right Z-Axis Scan	Channel 3 Channel 3
Plot 6	Touch Right Z-Axis Scan	Channel 1 Channel 1
Plot 7	Touch Right Z-Axis Scan	Channel 2 Channel 2
Plot 8	Touch Right with DC Power Supply Z-Axis Scan	Channel 3 Channel 3
Plot 9	Tilted Left Z-Axis Scan	Channel 1 Channel 1
Plot 10	Tilted Left Z-Axis Scan	Channel 2 Channel 2
Plot 11	Tilted Left Z-Axis Scan	Channel 3 Channel 3
Plot 12	Tilted Left with DC Power Supply Z-axis Scan	Channel 3 Channel 3
Plot 13	Tilted Right Z-Axis Scan	Channel 1 Channel 1
Plot 14	Tilted Right Z-Axis Scan	Channel 2 Channel 2

Plot 15	Tilted Right Z-Axis Scan	Channel 3 Channel 3
Plot 16	Tilted Right with DC Power Supply Z-Axis Scan	Channel 3 Channel 3
Plot 17	Face Position Z-Axis Scan	Channel 1 Channel 1
Plot 18	Face Position Z-Axis Scan	Channel 2 Channel 2
Plot 19	Face Position Z-Axis Scan	Channel 3 Channel 3
Plot 20	Face Position with DC Power Supply Z-Axis Scan	Channel 3 Channel 3
Plot 21	Belt-Clip Position Z-Axis Scan	Channel 1 Channel 1
Plot 22	Belt-Clip Position Z-Axis Scan	Channel 2 Channel 2
Plot 23	Belt-Clip Position Z-Axis Scan	Channel 3 Channel 3
Plot 24	Belt-Clip Position with DC Power Supply Z-Axis Scan	Channel 3 Channel 3

450MHz Validation Plot Numbers

Plot 1	Validation 27-02-03 Z-Axis Scan	450MHz 450MHz
Plot 2	Validation 28-02-03 Z-Axis Scan	450MHz 450MHz
Plot 3	Validation 01-03-03 Z-Axis Scan	450MHz 450MHz